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Scene in the Operating Room. Performance of an amputation of the thigh by the circular method.

RAILWAY SURGERY

A HANDBOOK

ON THE

MANAGEMENT OF INJURIES

BY

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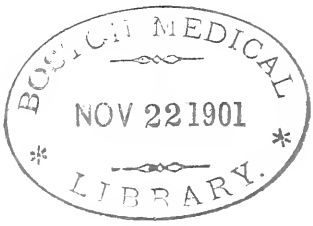

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TO THE MEMORY OF

SURGEON LEROY McLEAN,

This Volume is Dedicated

BY

HIS PUPIL.

PREFACE.

On account of the great increase in the number of injuries received on the railway, the peculiarities that many of them present, and the absence of any manual defining their distinctive features and their proper management, the following pages are introduced to the profession.

We freely admit that there are many railway injuries that do not present any points of difference on account of their cause, still it is believed that ability to note special features in any class of cases not only leads to the possibility of better judgment being exercised in the treatment of such cases, but enables one to secure more satisfactory results in the treatment of injuries of any nature.

This work, as its title implies, is intended merely as a practical handbook to show wherein the injuries ordinarily met with in railway service differ from those incident to other occupations, and to direct special lines in their diagnosis, treatment, and management.

There is no aim at scientific completeness, nor any attempt made to discuss theories or to settle dogmatic points. Some few cases have been elaborated, but in the main the colloquial style has been preserved. The book will not be found to treat of every variety of injuries, nor to go into detail in the consideration of any, but rather to

give concise practical directions for handling the every-day cases that are met with.

Beyond the lines of actual surgical work, such ideas as are advanced and suggestions given in the matter of general deportment in obscure cases, jurisprudence, examination of employees, etc., are intended merely as a guide in a general way to what the surgeon may expect to meet, and he may fortify himself to a greater degree, if necessary, by reference to special sources of knowledge on these matters.

CLINTON B. HERRICK.

1824 FIFTH AVENUE, TROY, N. Y.,
November 15th, 1898.

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RAILWAY SURGERY.

INTRODUCTION.

Railway surgery comes to us as one of the latter-day necessities, in the growing demand for special recognition of certain conditions which have sprung up out of the general order of medicine.

While injuries upon the railway have existed ever since the birth of the iron highway, yet anything peculiar or distinct in regard to them did not impress the observer until, as time advanced and this traffic became general, the injuries multiplied so rapidly that their peculiar features made themselves apparent to those coming into contact with such cases.

As all the nowaday specialties have been born in substantially the same manner, so railway surgery takes its stand upon the ground that distinct features mark the necessity for special consideration of the wounds received in railway work.

The surgeon who makes a special study of these features and their appropriate treatment, by coming more frequently into contact with this class of injuries, is entitled to be recognized as a railway surgeon.

As in all the special branches of medicine and surgery,

he takes his principles from the general art, and does not permit himself, in his deviations to meet the case with a special line of thought and treatment, to set aside for a moment the fundamental teachings of both.

CHAPTER I.

HISTORY — STATISTICS — GENERAL CONSIDERATIONS.

History.

THE first steam passenger lines were opened in both England and the United States in 1830. Beginning with 23 miles, in 1831, there were 95 miles; in 1840, 3,000; in 1850, 9,000; in 1860, 30,000; in 1870, 50,000; in 1880, 90,000; in 1890, 175,000 miles, and at present upward of 250,000 miles, in the United States. Operating these roads are some one thousand railway companies, who employ nearly two millions of men to give their brains and muscles in the construction, equipment, and management of these systems.

That much danger to life and limb is incurred by those who are thus engaged in this special vocation is self-evident, and even in localities where the strictest supervision and management are employed to avoid danger, the number of accidents is painfully large.

All railway corporations are continually looking into the means whereby even what may be considered a small number of casualties may be lessened. These accidents are a constant source of anxiety to the managers, and they, as well as the public before whose eyes are chronicled daily reports of calamities on the rail, are ever on the alert

to avoid such accidents. The adoption of the air-brake, the heating of cars by steam, the lighting by gas and electricity, the various block systems employed, the signals, the train-despatcher, and the flag-man, are all methods having for their main purpose the saving of life and limb of the employees and passengers.

In the far West, where on the line of the railways there were hospitals sometimes only once in hundreds, and sometimes in thousands of miles, and these railways employing many hundreds of men who were constantly receiving injuries or contracting illnesses, the demand first made itself felt that some provision must be made for their relief.

The idea of having hospitals at points along the lines was then adopted, and surgeons were appointed to take charge of them. This was early in the sixties. Up to within six or eight years there had been but few systems thus organized, and these mostly by the large trunk lines of the West. Within these few years, however, rapid strides have been made, and to-day more than a hundred chief surgeons are giving their time, skill, and experience to the proper care of their departments, and the number of local surgeons largely exceeds six thousand.

Not only do these surgeons attend to the wounded, but to the service in general, in the matter of examination of prospective and active employees as to physical defects incapacitating them for trusty duties, and to the looking into the sanitary condition of the cars, which is fully as important.

So many men thus being called into one line of work, societies have resulted, formed for the interchange of ideas and experiences, and at present there are a national associa-

tion, an academy, and many State associations of railway surgeons, as well as local societies confined to single roads or systems.

STATISTICS.

No mode of locomotion is safe, and it is very possible for us to be confronted with the fact that fewer persons are killed while travelling on the railway than in the pursuit of the ordinary avocations of life.

Charles Francis Adams truly remarks that, "after all, it is not the danger, but the safety of the railroads which should excite our special wonder. At the end of the year, of the millions of passengers, fewer have lost their lives through accidents than have been murdered in cold blood. Not without reason, therefore, has it been asserted that viewing at once the speed, the certainty, and the safety, with which the intricate movements of modern life are carried on, there is no more creditable monument to human care, human skill, and human foresight, than the statistics of railroad accidents."

In one year about 800,000 men are employed in active train service. During the past year (1897) 1,693 were killed and 27,667 injured. In the same time but one passenger was killed out of two and one-quarter millions (or exactly 2,204,708) carried, and one injured out of 175,115. Of all these casualties 6,437 resulted in death and 36,731 in injuries of varying character.

Noting the fact, then, that there are over 40,000 human beings injured by railway accidents each year (making 3,300 monthly, 113 daily, and 5 every hour), we find sufficient evidence of the importance of railway surgery, and

the desire to give these cases the best possible assistance has been the means of evolving the present systems of railway relief.

If we further consider these statistics we will find that the brakemen are injured the most frequently, next the switchmen, then the firemen, and then the engineers, in direct relation to the hazard of their duties.

As to the manner in which injuries are received, the majority are injured by coupling cars, next by jumping upon and alighting from trains in motion, then by falling off of cars, then by derailment and collision.

As regards the passengers, more are injured by derailment than by collision and falling from trains.

The employees are, in the larger number of instances, injured in the upper extremity, these reaching one-half of all. About one-third are injuries of the lower extremities, one-eighth of the head and face, and one-twelfth of the trunk. We see, therefore, that the brakemen who couple cars and receive thereby injuries of the upper extremity, make up the majority of cases met with.

General Considerations.

A freight-car has at its ends a large block of wood or iron on either side of the centre which acts as a bumper when the car comes against another. Between these bumpers, on the same line, and extending out from the car about the same distance, is a forging of iron called a drawhead, by means of which a coupling is made to other cars. This has a slot in the end into which a link slides, being held in place by a pin of iron, dropped into a hole

through the drawhead from above (see Fig. 1). In the act of coupling, a brakeman enters between the cars as they come together, and holding up one end of the link, which is already pinned to the drawhead of the other car, he guides it into the slot in the drawhead of the next car.

As the links are not over twelve inches in length, the approaching drawheads must be brought within a few

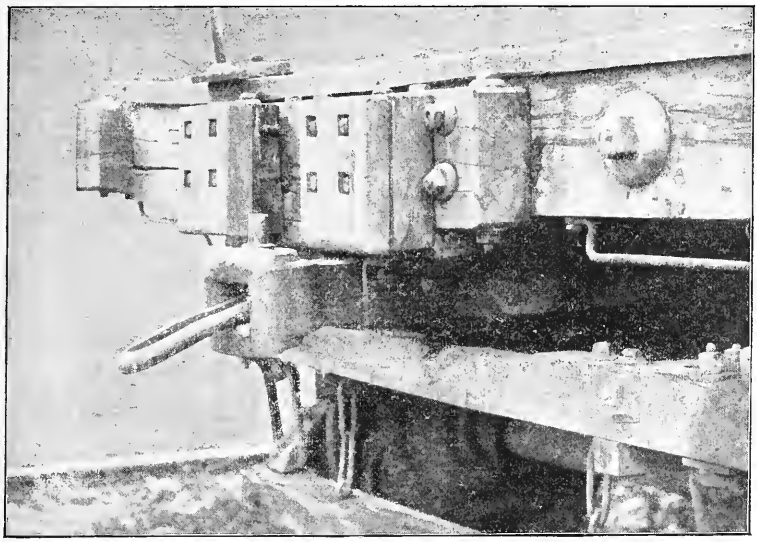

FIG. 1.—Ordinary Car Coupling, showing the link held in the drawhead by the coupling-pin. The bumpers appear just above the drawhead, one on each side.

inches of each other before the point is reached that the man can withdraw his hand, which he must do on the instant or get it caught (see Fig. 2). Besides this, the couplers and bumpers of cars vary with each line, both as to size, shape, and position, making it extremely hazardous and difficult for a coupling to be made with safety.

It is gratifying to note that the law is gradually stepping in to prevent cars being built with this hazardous

coupling attachment. Many devices for the automatic coupling of cars have been designed, with the aim to arrive at a construction that will permit the brakeman to

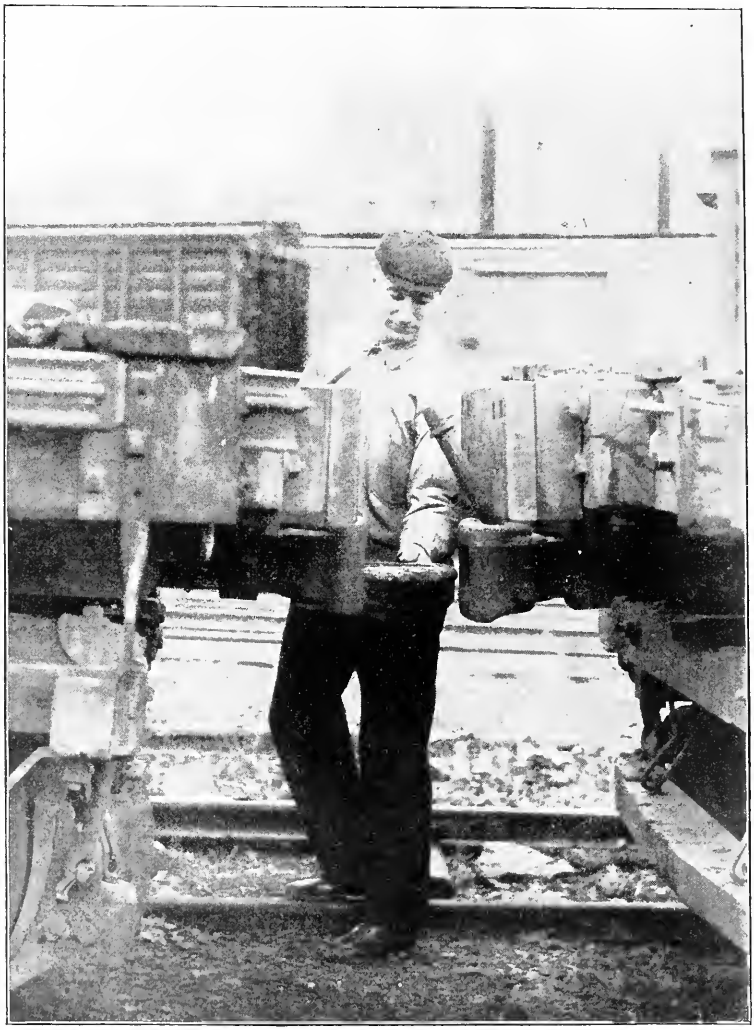

FIG. 2.—Showing how Cars are Coupled Together. The link is being guided into the drawhead of the stationary car.

stand well clear of the cars as they come together and lock themselves. Passenger coaches throughout the country are at present quite well equipped with such arrangements, but upon the freight cars there are comparatively few. There are enough of them in present use, however, to make the gradual decrease in the number of injuries to the hand and fingers during the past ten years notable. With the universal adoption of such automatic couplers, these injuries will be more unusual.

While the larger number of railway injuries are of a minor character, still, in order to appreciate just how severe any injury is, it is imperative that the body or force which caused it be carefully considered, and the more closely we are acquainted with such force and its effects, the more certain we are to arrive at a definite conclusion as to what we are called upon to treat.

It is undeniably true that any surgeon is capable of appreciating the fact that a leg or arm has been crushed off, or a skull or long bone fractured, but there has been a very deceiving force at play in the production of railway injuries which cannot help operating as a factor frequently to disguise the real condition, and to lead to a wrong presumption those unaccustomed to come in contact with this class of injuries.

Surgeons have many times overlooked the gravity of several of these injuries that certainly had every appearance of being but minor, to the disadvantage of the injured and the risk of their own reputations. And these mistakes were not made through any lack of ability, but from failure to realize the character of the force at work.

We cannot look upon an extremity which has been in-

jured by having a train of cars pass over it as being in any way similar to one crushed from other causes. Injuries produced by heavy machinery come the nearest, perhaps, to it, but even here the violence has not been that of a moving body carrying with it an additional force depending upon its velocity as well as upon its weight. Such a force produces wounds that are more severe than those ordinarily seen by the surgeon, and the cases are more grave when, as frequently happens, they occur at some distance from surgical aid, adding exposure, travel, shock, and hemorrhage to the existing condition.

The railway surgeon meets in his practice nearly all classes of injuries that are seen elsewhere, but the vast majority of them have, as a complication, tearing and injury of the soft parts, and many of them multiple in nature, from the powerful forces which have come into play in the production of the injury. This, then, urges upon us the necessity and the importance of exercising the greatest care, and of taking advantage of every experience in railway accidents.

General surgery hands down to us the principles from which every special branch is reared, and the technique of railway surgery differs but little from that of general surgery, although as regards the injury, its manner of production, its probable course, its treatment and prognosis, special training is of great importance. From the fact that such an army of railway employees are annually injured, a study of cause and effect has been made, which, coupled with experience, has led to the recognition of the special features connected with this class of injuries.

CHAPTER II.

THE RAILWAY SURGICAL SERVICE—EMERGENCY PACKET—HOSPITAL CAR.

Surgical Service.

Heretofore, those injured on the railway were attended to in any manner that seemed most convenient, but, unfortunately, this was not always the best by any means. The presence of a doctor on the train was looked upon as providential, and even he would dress the case temporarily. In lieu of this a local physician was sought, and the man transported for many miles to his home or to a hospital, the interval frequently being one chapter of agony and of a fast ebbing life.

Take the usual instance of a man severely injured, as, for example, having one or both arms or legs crushed. He was usually tied up with rope, old rags, soiled handkerchiefs, or anything else lying about, lifted into the first train, possibly some time after being hurt, with his crushed members dangling behind him unsupported; then sent along the road many miles in a cold damp car, each start and jar of which would almost close the scene, only soon after to be hustled into an ambulance and hurried to the hospital.

What is his condition when arriving there, and what chances are left for the surgeon to work upon? Usually,

he presents a pallid, grimy appearance, is pulseless, cold, stupefied; the crushed arm or leg so mixed up with clothing, gravel, sticks, etc., that the whole mass looks like nothing but bloody rubbish. It is our frequent experience to bend over such a case, and say, "Nothing can be done for this man. He cannot bear an operation." He has been jostled and bled to death, and so he dies.

Even in the less severely injured, the wounds have been poisoned by long contamination with dirt to such a degree that a good result is wellnigh impossible.

Now, by reason of an organized relief service, the surgeon is despatched to the injured person. Arriving there soon after the accident, carrying all the necessary materials, he applies a proper primary dressing, which tends to change the whole future aspect of the case into a favorable channel. He judges of the man's condition, administers such restoratives as are demanded, and if consistent, the man is at once taken to a company or other hospital, to be cared for. In case the man is too severely injured for this procedure, he is cared for right where he is, and all the sufferings and effects of transportation are avoided until he is in a condition to withstand them.

As we see the benefits accruing to the employees by the systems thus devised and practised, we find that to the physician himself there is some value to be gained. Firstly, the experience he gains in this line of work enables him to treat these cases in a scientific manner, with a knowledge of the fact that his treatment will stand criticism. Again, on account of the unexpected hour of need, he is trained to be always ready, the influence of which training will be felt throughout his practice, attaining for

him a reputatation at once as a practical, thoroughgoing man, whose methods of promptness commend him in any case requiring his professional aid.

For the railway corporations employing such a system there is much to be gained and nothing to lose. They are gradually recognizing the importance of a surgical service, and are adopting it, in varying degrees, finding it at once economical, humane, and satisfactory.

For the public good there is much to be attained through the agency and labors of the railway surgeon. Being associated in a confidential manner with the officials, he is in the best possible position to urge the necessity for car sanitation, which is growing to be a most vital question.

In addition to all this, the corps of surgeons have in mind the possible contingency of chapters of accidents on the road, and are continually devising and planning for the benefit of both employee and passenger, one of the most valuable aids thus provided being the "Emergency Packet" which is recommended to be placed on board of every train.

Emergency Packet.

Such a packet advised by the author is arranged as follows (see Fig. 3):

A tin box eighteen inches long, three and a half inches wide, and two inches deep, having a hinged cover, contains the following articles:

Four plain wood splints, three by eighteen inches.

Four muslin roller bandages, three inches by five yards, with pins inserted.

Four Esmarch triangular bandages.

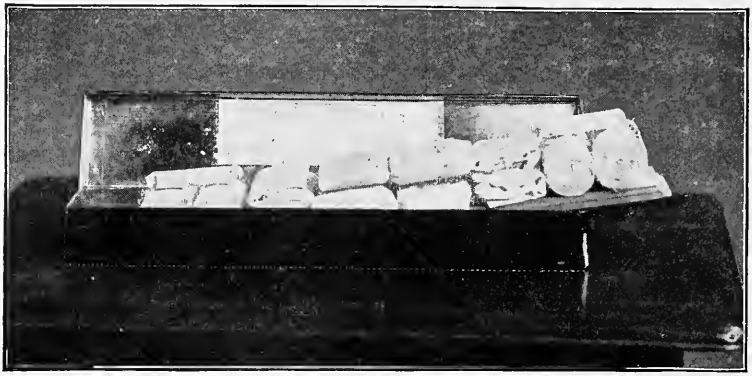

FIG. 3.—Emergency Packet; opened to show contents.

Four packets of sublimated gauze, one-half yard length in each, sealed separately in germ-proof paper.

Two two-drachm phials, each containing in solution one-quarter grain morphia sulphate and one-thirtieth grain strychnia sulphate.

The box is lined, and the articles are carefully covered, with germ-proof paper, while inside the cover is printed the following:

"DIRECTIONS.

"Cover wounds well with gauze, roller bandage snugly over all.

"In severe bleeding, roll bandage tightly around ABOVE wound, until controlled.

"If bone broken, splint each side, tie folded bandages to hold same firmly in place.

"For pain give contents of one bottle."

The employees are instructed in the use of these first aids that they may be the more efficient. Stretchers are placed at important stations for the reception and handling of the injured, and in many similar ways provision for relief is being continually made more complete.

Hospital Car.

The more perfect arrangement is the hospital or relief car, which has been advocated for a number of years by the author and which has been already adopted by a number of roads in this country. A car of proper length is divided into three compartments (see Fig. 4). One at one end is used as a sitting-room for the surgeons in transit. The middle room of the width of the car, save enough to permit a passageway on one side from one end of the car to the other, should be the operating-room (see Fig. 5). It should be lighted by a large skylight, the floor should be tight, there should be suitable closets on the sides for a full stock of dressings, racks for vessels containing a large quantity of sterilized water and various solutions selected by the surgeons, and a water-boiler operated by a blow-lamp. A table in the centre,

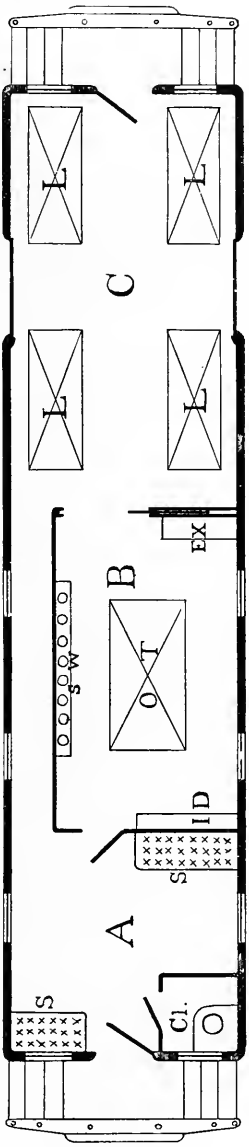

FIG. 4.—Floor Plan of a Hospital Car. *A*, Sitting-room; *B*, operating-room; *C*, transportation-room; *Cl*, closet; *S S*, seats. *I D*, instrument and dressing case; *O T*, operating-table; *S W*, sterilized water and solutions, in racks; *E X*, extra sheets, blankets, and other materials; *L L*, beds.

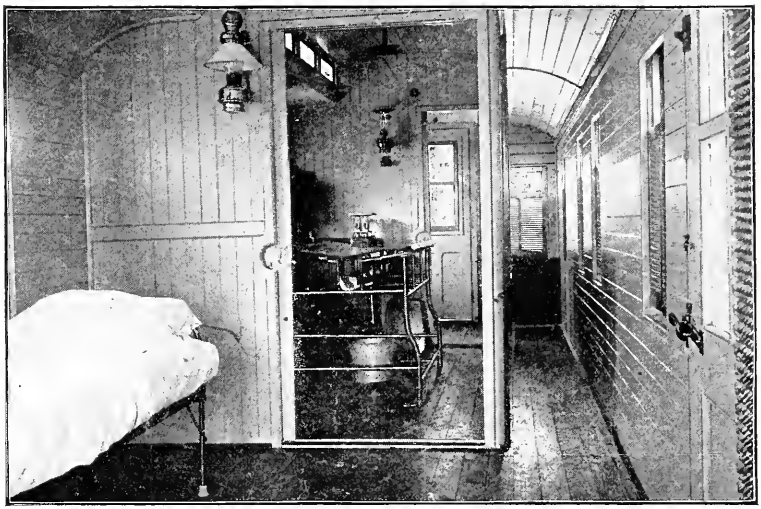

FIG. 5.—Hospital Car (Plant System, Fla.), looking from the transportation-room into the operating-room, showing operating-table and other arrangements; also shows the passageway to the opposite end of the car.

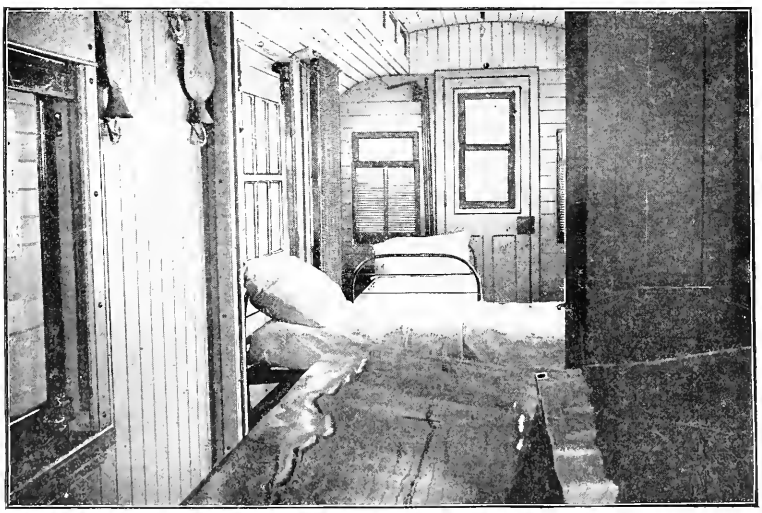

FIG. 6.—Hospital Car, looking from the operating-room into the transportation-room, showing beds made up ready for occupancy.

and two or more swinging shelves and stands, all capable of being fastened to the floor, complete the furniture. A wide door should lead from this into the remainder of the car, which at the full width constitutes the transportation-room, with wide doors on each side opening out of the car. Within this room should be placed a stretcher swung by suitably arranged elastic springs from the ceiling, with stays to prevent too great motion, and several cots made up with blankets (see Fig. 6).

Upon reaching the scene of the accident, this car is side-tracked, the injured man taken into the transportation-room, and his soiled clothing removed. Then he is taken into the operating-room, the hemorrhage checked, all irritating and shock-producing dangling members are removed, and stimulants and anodynes administered.

On being taken from such a car to a hospital, or to his home, he presents a far different picture from that portrayed at the beginning of this chapter. He has more chances of recovery, and he himself, as well as the surgeons and officials of the road, rests content with the knowledge that every effort has been made for the best possible results.

CHAPTER III.

A STUDY OF THE FORCES AT PLAY IN THE PRODUCTION OF WOUNDS ON THE RAILWAY.

It is well to look into the matter of the different degrees of force which may be produced by the railway, and thereby to understand that a class of wounds may be inflicted which differ from those received in other ways.

It is fair to presume that when any force bears against a part of the human body to a sufficient degree, a wound or a solution of continuity in the skin and subjacent tissues will be produced, of varying severity, in accordance with the nature of the force applied. So far, it would not make any difference what the force was, or how applied, similar conditions would produce similar wounds. But between the force which may be exerted by railway engines and cars, and that of other mechanical construction, there is so great a difference as to change the condition of things to a very marked degree.

A man falls from a high building, and his entire weight strikes on the pavement below; a mason has a huge granite block fall upon his leg; a laborer has a bank of earth cave in upon him; or a pedestrian is run over by a carriage, a loaded wagon, or a fire-engine, but what does all this amount to in comparison to a railway train? A

few hundred pounds, or a few tons weight, is all there is to it, averaging less than from one-twelfth to one-hundredth of that capable of being produced by railway cars.

For instance, an empty flat-car weighs from eight to ten tons, a box-car from ten to sixteen tons, a passenger coach from twenty to forty tons, a Wagner car sixty tons, or more, and a locomotive from ninety to one hundred and ten tons. Where in other occupations do we find such heavy bodies to be constantly moved, such force to be dealt with, as we do in the railway service, for we note that these weights are those of the cars at a standstill?

Take a man's leg, and permit an object of any weight to be carefully and gradually lowered upon it, and it will be found that a considerable number of pounds pressure can be maintained without causing any break in the tissues. Raise such a body to varying distances and allow it to fall upon the leg, and the damage produced will be more severe in proportion to the distance the body has fallen.

In other words, the increase in distance increases the velocity of the body through the force of gravitation, and this, added to its weight, increases the damaging effect in ratio, increasing with the distance.

Very light bodies, falling great distances, have been known to produce effects out of all proportion to their weight. It is not the powder behind the ball *per se* that determines or causes the disastrous effects of the projectile, but it is the speed at which the same is travelling at the moment of impact.

Now, this is just where one special feature of railway surgery hinges. Instead of gravitation, there is the speed developed by means of the moving locomotive with the force of many horse-power, augmented by the inertia of the moving mass.

The weights of the various cars and engines that have been given are those of the same at a standstill. As accidents on the rail do not occur while the rolling-stock is at rest, we must increase the force given many times until, when a train is moving at a speed of fifty to seventy miles an hour, the force of impact that is exerted on any object struck by it is almost incalculable.

That which also has the effect of producing severe wounds is the fact that the enormous weight of a train rests on the hard, resisting body of a steel rail, and between these two the leg or arm is impinged.

In comparison with this, if a heavy weight falls upon a body while it rests upon the ground, or upon anything that will give way before force, there is a certain amount of resiliency in play that tends to reduce the amount of crushing force and its effects.

Another point which adds destruction to force is the shape of the rail and that of the tread of the wheel of the cars and locomotive. The former of the shape of the letter T, and the latter having a flange on the inner circumferential edge which reaches for an inch or two below the surface of the rail, cannot but act very much like a knife, tending to hash anything that it passes over (see Fig. 7). There is a little space between these flanges and the rails, to allow perfect play for the engine or car running on the rail, and this helps to account for

those cases in which the skin remains unbroken after having been run over, in that its elasticity permits a stretching of it to occur in this space between the rail and the flange.

Then how can one imagine the similarity of conditions produced by an aggregate mass of several hundred tons

FIG. 7.—The Car Wheel upon the Rail, illustrating the flange on the inner edge of the wheel, and the space between this and the rail.

moving along at a speed of many miles an hour, hurling its crushing force of a thousand tons or more against the body, with any force possible to meet in the daily avocations of men? One shudders to think of the terrible result that must ensue when an express train crashes upon a human being.

It has been said, and, without doubt, truly, that nowhere, even in the horrors of war, when a bursting shell or a charge of grape shot would tear men apart can such awful results ever be seen.

There is no wish to convey the impression that railway

surgery is as bloody as a slaughter-house, and that all cases met with are such severe ones. On the contrary, many are very slight indeed, and inasmuch as they are so, they have no points in particular from those seen elsewhere, and may be treated as such.

CHAPTER IV.

RAILWAY WOUNDS: THEIR NATURE, HISTORY, APPEARANCE, AND DIAGNOSIS.

The Nature of the Wounds.

In railway surgery we have sometimes to deal with conditions that are appalling in their severity, as well as in their effects, both locally and constitutionally, by reason of the crushing force; while in ordinary civil life and practice, the injuries met with are comparatively moderate and superficial.

History.

The history of a railway injury is usually easily obtained. The blood stains will direct immediate attention to the location, except in lesions of the head and internal organs that may be uncomplicated with external wound. The average railway employee is a rugged, gritty man, who bears injury well, and from him or his comrades the facts regarding the speed and weight of the train can be elicited, in order that a basis can be obtained upon which to build the foundation of a true conception of the case.

One thing to guard against is the inaccuracy of description regarding the exact manner of injury, even by eye-witnesses. The excitement and shock of witnessing a

person about to be injured, or possibly killed, cannot but act as a means of diverting impressions and vivifying imaginations so that the statements may be absurdly incompatible with the result found.

We have been told of a brakeman who was "knocked down and run over by a train of fourteen cars, upsetting the first and derailing all the rest," when but a simple fracture of the femur had occurred. Another had "an engine and tender run over his leg," and the engineer averred that he felt the jar of the locomotive as his machine passed over the leg; the man sustaining a lacerated wound, and going to work in a week. Two witnesses claimed to have seen a man "knocked down and a loaded coal-car pass over his thigh," but no bones were found broken.

While inquiring into the cause of the injury in regard to the speed of the train, and how the person was caught, etc., all this must be taken into account and due consideration given it, realizing that cause and effect must be along compatible lines in any class of cases. The fact of the matter is, that many times when a person in the belief of an eye-witness has been run over by a wheel, the latter has slid the member along the rail, finally pushing it to one side, the result being a possible fracture, or a bruise more or less extensive upon one segment of the limb. In these cases the condition of the skin, in the fact that the bruise covers but one side of the extremity, aided by the absence of preternatural mobility and signs of destruction of vitality to the part, would lead to a proper conception of the extent of the injury.

Slow-Train Injuries.

Many of the accidents with which we come in contact are not caused by fast, but by slow trains, as in switching and coupling, and these carry much less force of velocity. But we find that these wounds are different in certain ways from those received by fast trains, and are more nearly similar to wounds received from other machinery and heavy bodies.

If a hand or foot is placed in a vise, and this is screwed up, squeezing or jamming the parts held in its grasp, what happens? If the pressure has been severe enough, the bones are broken and the soft parts reduced to pulp, but the line of such destruction is marked by the line of the edge of the vise.

In bumper accidents, or in the case of a leg or arm being run over by a train or car at slow speed, it will be found that, just as in the case of a vise, the parts have been squeezed or pulpified, leaving a margin marked by the edge of the bodies between which the member has been caught, and it will be discovered by dissection that the tissues adjacent to the lesion are practically normal. Fig. 8 represents a case in which the wheel passed over the foot, squeezing its contents, like pulp, out through the rent in the skin. Amputation made close to the upper border of the wound disclosed the tissues to be uninjured at this point.

The actual appearance of these bumper injuries is by no means always so sharply defined as to margins, for the irregularity of outline of the impinging body meets the

irregular one of the hand and fingers in a manner anything but direct, unless one finger only is impinged. The elastic skin may tear, and the small bones be uncovered

FIG. 8.—Crush of Foot, showing extrusion of muscular tissues.

or protruded, leaving the fingers to hang in a limp, lifeless, shapeless mass, still the fact remains that the damage seen is the full damage done, and can be so considered in treating the same.

FAST-TRAIN INJURIES.

In the case of a fast express train passing over any part of the body a different state of affairs is presented. While the lesion may in some instances be apparently just as sharply defined as in the other case, the fact is that destruction has been accomplished way beyond this margin, and what appears to be uninjured tissue is in reality dead, or so devitalized that it will die, by reason of the shock to which it has been subjected through the impact to the part by such a powerful force. This condition

exists for varying distances from the line of apparent injury, according to the speed and the weight of the train.

The actual cause of death of these tissues beyond the line of wound is the plugging, for varying distances, of the large artery of the part by a coagulum of blood.

To illustrate this, will be noted the case of a boy who, while trying to catch a ride on the train, was thrown underneath it, several cars passing over both legs. The left foot was crushed to the ankle, and the right one to the middle third of the leg. The left leg was removed at the middle third well above the injury in order to get into sound tissue, and did nicely. The right was amputated at

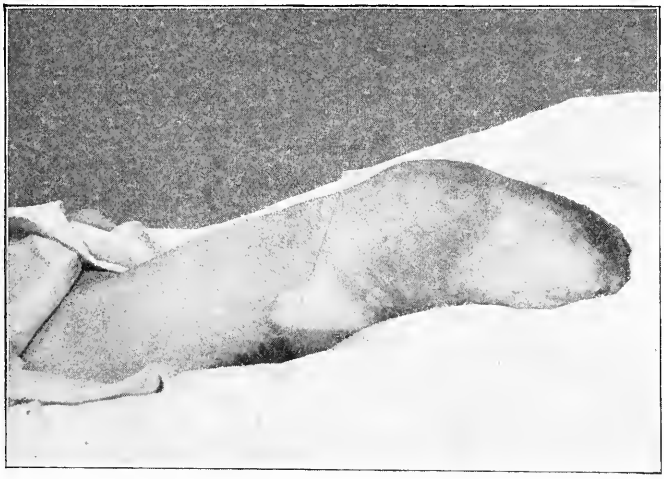

FIG. 9.—Gangrene of Stump reaching to Middle of Thigh, subsequent to operation close to margins of a crush inflicted by a fast train.

the upper third of the leg. In forty-eight hours this latter stump became discolored, and the discoloration continued to increase until a distinct line of demarcation appeared at the lower third of the thigh (see Fig. 9). Gangrene

rapidly supervened, and amputation was made in the middle third of the thigh, the case subsequently doing well (see Fig. 10).

The popliteal artery was dissected out, and found filled with a long plug of coagulated blood (see Fig. 11), com-

FIG. 10.—Final Result in the Case Noted in Fig. 9.

pletely shutting off the circulation below the coagulation; having, without doubt, been caused by friction and the

shock to the tissues through the force of impact, and was essentially the cause of the gangrene.

FIG. 11.—The Popliteal Artery from Case Shown in Fig. 9, showing the plug of coagulum occluding it.

This fact has been proven: that the line of wound is but an indication of the extent of real injury, and that the speed of the train must be considered together with the condition of the injury, in order to arrive at any definite conclusion as to how severe it may be and as a guide as to how it should be treated.

Aside from the manner in which the injuries are produced, it is found that the large majority are contused or lacerated to a considerable degree, and that in nearly all there is the complication of fracture of one or more bones, and these latter are frequently in a state of comminution.

APPEARANCE OF THE INJURY.

The appearance of the wounds received on the railway is very frequently misleading. A train of cars may have passed over the arm or leg, especially when the latter is

covered with clothing, without so much as breaking the skin, although all underneath is reduced to pulp. This is probably due to the elasticity and toughness of the skin, and is even seen at times in coupling accidents in the hand, where it has been bare.

Palpation of such an injury will not always guide one correctly, and if the extent of injury is obscure, a slit in the skin will give the opportunity to examine and find the ex-

FIG. 12.—Legs Run Over by Car Wheels, showing no break in the skin. The dark spots are ecchymoses.

act state of affairs. This is one of the unusual conditions, and is seen, as a rule, only in cases in which the wound has been caused by a train moving at a slow speed. The skin shows a denuded surface and appears as if scorched, from friction and pressure, at the point where the wheel and rail come upon it. Fig. 12 is a photograph of a case in which a loaded car passed completely across both legs. The dark spots are ecchymoses, almost eschars, but the

skin of the left leg remained perfectly intact. The fractured bone of the right leg forced its way through the surface at a point close to the knee. A subsequent section of this case showed the muscles and vessels completely cut across, and the bones comminuted (see Fig. 13). This particular feature is not observed in injuries resulting from

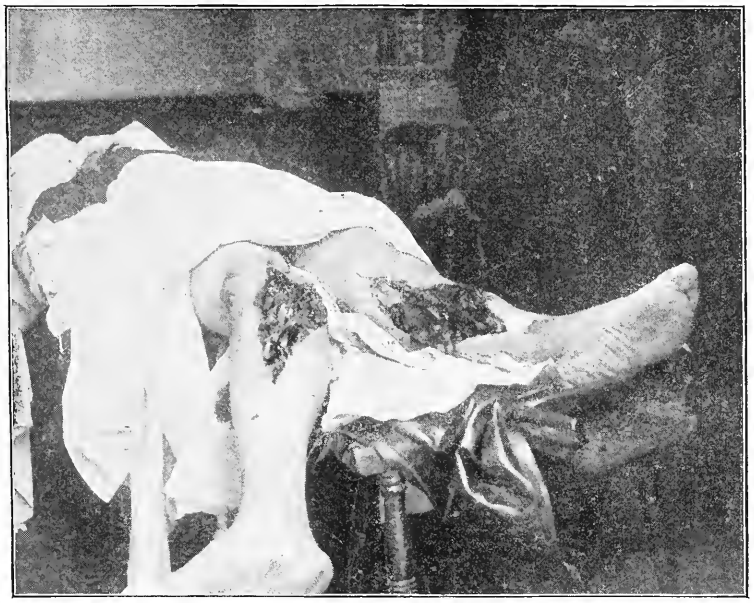

FIG. 13.—Section of the Case Noted in Fig. 12, showing the destruction of the tissues.

fast-going trains, for here the extremity is, as a rule, completely severed, save perhaps a few shreds of skin holding the distal fragment.

The actual conditions that we see vary from a simple ecchymosis or bruise to a crush of an extremity (see Fig. 14). The latter presents ragged ends of torn skin with blackened edges, the bone, fractured to comminution, protruding irregularly. The hemorrhage is usually quite

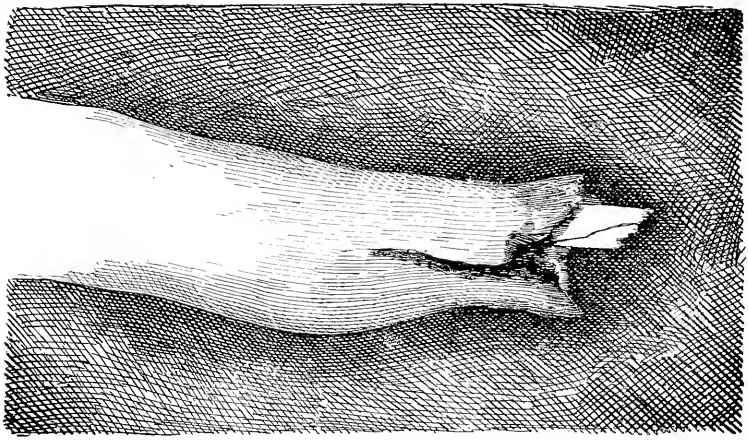

FIG. 14.—Appearance of Proximal Portion of Leg completely Crushed Off.

moderate on account of the tearing of the vessels, unless a large artery has been severed, in which case the bleeding is

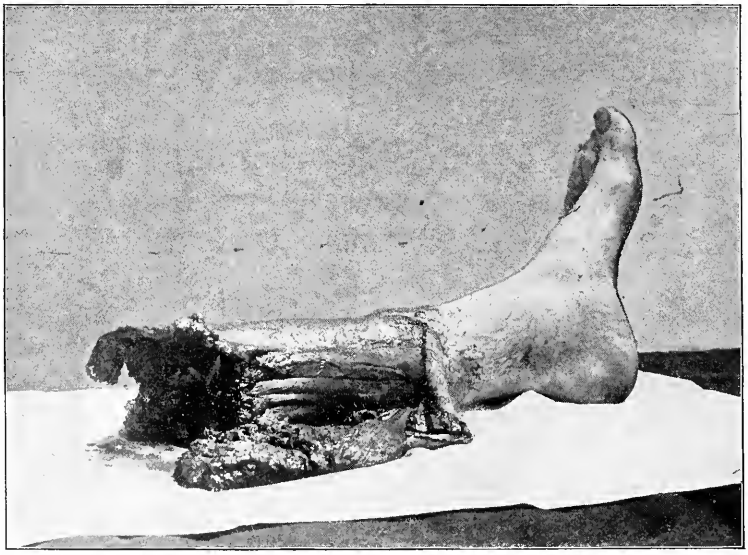

FIG. 15.—The Distal Portion of a Leg which was completely Crushed Off by a Fast Train.

very profuse, and not infrequently fatal. Oftentimes the part which has been run over is completely torn off, leaving a ragged, fringed surface, which when mixed up with cinders, shreds of clothing, and bloody *débris*, is almost un-

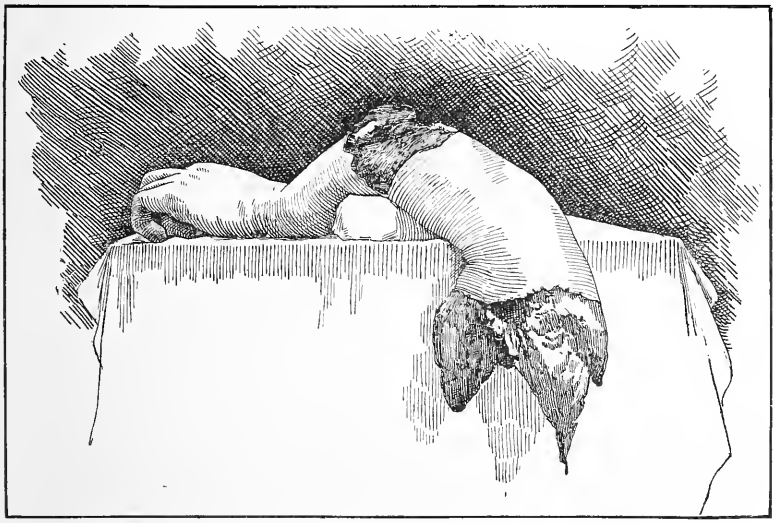

FIG. 16.—An Arm that was Fractured and Torn Off by a fast Train.

recognizable as belonging to any part of the human anatomy. Fig. 15 represents the distal portion of a leg completely crushed off, and Fig. 16 shows an arm that was completely torn off by a fast train.

CHAPTER V.

CONDITIONS ASSOCIATED WITH RAILWAY INJURIES—SHOCK AND ITS TREATMENT—SEPSIS AND PRIMARY TREATMENT OF THE WOUNDS—TRANSPORTATION.

Shock: Its Cause, Degrees, and Diagnosis.

A condition which is especially prominent in railway injuries is shock. This is defined as being a condition of depression of all the vital powers of the system, varying in degree from a slight syncope to a condition resembling death. Caused by the disturbance to the animal economy, as well as by the mental terror of being injured, it operates as a very important factor in the prognosis of any case.

There are many conditions that may bring on shock, such as mental emotions, injuries, surgical operations, burns, poisons, pain, and hemorrhage. In the majority of cases the condition directly follows upon the influential cause, but we do meet cases among the strong-willed, who, realizing that they must put forth all their efforts to self-preservation, strain every fibre until they are conscious of being cared for, when they suddenly drop off as if shot, into a condition of shock.

The degree of shock usually depends upon and follows the degree of injury, but not invariably, as we know that a

slight blow on the epigastrium or testicle will often be followed by extreme shock; and the sight of blood from a very minor injury sends some very sensitive persons into collapse. The mind then has something of an influence in the production of this condition. In cases of very severe injury, or of excessive hemorrhage, even the strongest are overcome and sink into a state of collapse.

The degree of stupor into which a person may thus fall may result in a mere faint, in which the face becomes pallid, and consciousness is lost for a few moments, the skin remaining dry and the circulation full, but rapid, a condition in which anything that is imperative regarding the wound may be promptly attended to without waiting.

When, however, shock is met in its severest type, there is present a formidable condition, requiring every effort to antagonize. It will be found that a person in such a condition is very near to death. He presents the following picture: skin ghastly pale, lips and gums colorless, eyes sunken and lustreless, a clammy sweat covering the body, a pulse imperceptible at the wrist, heart's action weak and rapid, respiration slow and regular, and a total unconsciousness.

We may find any of these signs modified, and we have even seen consciousness prevail with all the other severe conditions noted above. Whether conscious or not, the patient will not usually complain of pain, as all the senses are obtunded and remain so until reaction occurs.

After the accident has occurred, there are some conditions that will continue to add a deleterious influence to the existing state of shock, chief among these being hem-

orrhage and the surroundings of the individual. Therefore, while every effort is being made to restore the condition of the patient, these two matters must be promptly attended to.

Treatment of Shock.

In the minor degrees of shock a dash of water or a drink of the same with aromatic spirits of ammonia or whiskey, or a hypodermic of one-one-hundredth grain of nitroglycerin, or one-thirtieth grain nitrate of strychnia, or a hypodermic syringeful of whiskey, will probably combat the shock successfully.

In the more severe cases, in addition to hypodermics of the above, which can be and must be pushed to their fullest limit, the patient should be placed at once in warm quarters, well protected with warm covering, and, if possible, bottles of hot water placed all around him. His head should be kept lower than the body, and absolute rest enjoined. At the same time the hemorrhage should be promptly looked after. In case the crush is not complete, this can be best controlled by firm pressure, after having, as a matter of course, made everything as clean as possible in the vicinity of the wound. If the crush has been complete, and the distal fragment is entirely gone or hanging upon a few shreds, cut these off and apply as many hæmostatic forceps as are necessary, leaving them *in situ*. In lieu of these an Esmarch bandage, snugly applied around the extremity as near the wound as possible, will give absolute control of the bleeding.

It is needless to say that in such profound cases nothing, absolutely nothing, more should be done than the

above in the way of operating upon or transporting the patient. As pain is a factor in keeping up shock, this should be relieved, and should be anticipated by a hypodermic of one-fourth grain of morphine at the beginning, and repeated in half an hour if necessary.

Between these two extremes many cases of shock are met with which while present require to be looked after in some of the particulars above outlined; yet they do not entirely preclude operation if such be a matter of immediate necessity. If there is, in the judgment of the surgeon, a fair condition of the vital powers present, and the question of the necessity for operation of some kind decides itself in the affirmative, there is no reason why this should not be done. The operation would, when accomplished, place the case in a direct way to improvement by removing one factor in the case, namely, mangled tissue.

Sepsis, and the Primary Treatment of Wounds.

As sepsis is a condition that comes very prominently before us in the handling of these wounds, every effort must be made to combat its influence from the very start. As soon, therefore, as the severer conditions noted above are attended to, we must proceed at once with the dressing of the case, at least temporarily. And this temporary dressing must be thorough in every particular, for we know that upon it will depend the future progress of the case. If the germs left in such wounds are not thoroughly removed from them by proper agents, and kept out by protective dressings, there will culminate an infection which may not confine itself to the immediate neighbor-

hood of the wounded area, but disseminate itself throughout the adjacent tissues. The effect of this infection will of course soon show itself in a general way by the appearance of chills and high temperature, and will serve as an additional factor to a bad progress of the case.

During the first moments, then, attention must be directed to the application of a dressing that will serve to hold the propagation of these germs in check, and to assist by its influence a restoration of the individual from the state into which he has been thrown.

First, then, as to the skin. From the very nature of his occupation, the railway employee is begrimed with oil, soot, grease, and cinders, rendering the skin very septic, and upon being wounded this dirt is ground right into the fresh wound.

Spirits of turpentine will be found to be the most valuable agent for removing this blackened covering, and is as well antiseptic. After carefully cleaning out the crevices, as well as the surrounding surfaces of the skin, proceed to pick out all the *débris* that will probably be found filling the wound. At times this will be difficult, as this *débris* will be ground into, and will be sticking close to, the tissues. It will be accomplished, after the exercise of some patience, with a pair of forceps, after which the depths of the wound should be thoroughly washed with water, followed by a strong solution (at least 1 : 1,000) of bichloride of mercury.

After securing the bleeding points the wound is ready to be closed. If ragged, no attempt should be made at coaptation further than what can be done by pledgets of gauze placed about the edges of the wound. Stitches

should never be employed, except in the case of an overhanging flap as a simple matter of support. Especial care should be given the matter of drainage, and free space given for this, assisted by a tent of gauze carried to the bottom of the wound. As above noted, if the distal part of an extremity is altogether severed and gone, or still remains attached by a few shreds, snip these off, and apply the dressing to the open end.

After all attentions have been completed as above directed, cover the wound well with five-per-cent iodoform gauze, and enough plain gauze to make a large absorbent dressing. Support the parts by splints, which should be snugly bandaged over all.

Such a dressing will be a perfectly proper one to allow to remain on for a number of hours if an operation is to be the outcome of the case, or otherwise it may be left on until the ordinary time for a redressing in any class of wounds, that is, when the discharge makes its way through the coverings. As there is always considerable oozing for the first few hours, this redressing will probably be called for, at least, within twenty-four hours.

Transportation of the Injured.

A person who is so injured as to be in a condition beyond that of very slight shock, should be kept as quiet as possible until reaction has begun. If transportation to any distance is imperative, he should be carried in a recumbent position, the head kept low. Not only should the injured part be well supported, but that entire part of the body should be immobilized, so as thoroughly to pre-

vent motion in the adjacent parts or joints. Having been stimulated and relieved from pain by suitable agents, he can then be taken quite a distance without any marked degree of danger. There is no question, however, but that this will do much toward making a bad matter worse.

In severe cases, therefore, follow this rule: If the condition surrounding the person at the point where injured,

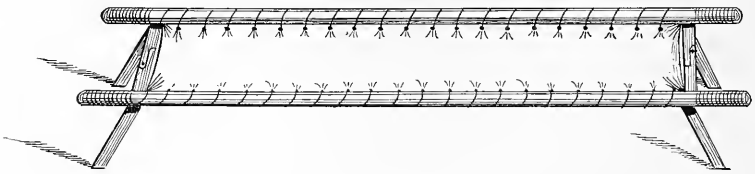

FIG. 17.—Form of Stretcher suitable for railway service; wooden rods, iron cross-bars, and canvas interlaced.

or in the immediate neighborhood, cannot be made a comfortable one, and keeping him there would be attended with greater risk than his transportation over the necessary distance, with the special advantages for treating him at this objective point, then removal may be advised. But if the distance to this place is great, and the neighborhood

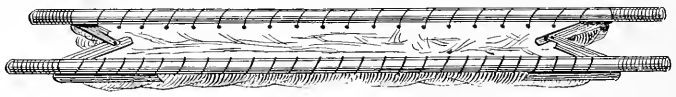

FIG. 18.—The Railway Stretcher folded for storing.

and conditions at hand present comfort, do not take any risk whatever in the matter until the case assumes a condition beyond doubt.

Inasmuch as it will be readily noted in the above that there are many features outlined that are akin to general surgery, and conditions precisely like those that may be met in the streets, and these perhaps be the first cases the

surgeon is called upon to treat in his practice, a few general points of advice may not be amiss: Be quick to observe the evidences of injury. A few pointed questions as to cause, or a hasty glance well directed, will enable the principal features of the case to be at once comprehended. Never get excited in a crowd, or appear other than calm and methodical in manner and procedure, by which bearing, confidence will be at once inspired, both in the observer and in one's self. Look well to the presumptive diagnosis, but never be hasty in giving it, knowing that many serious conditions frequently lie obscured under minor appearances. Multiple injuries may be present, and if so, the severer one should be treated first. If other physicians are present, divide the work so as to save time and perhaps avoid serious results. This may prove of importance in the event of the case becoming a medico-legal one at a later period.

CHAPTER VI.

THE EMERGENCY CASE—PREPARATION OF MATERIALS—STERILIZATION—ANÆSTHETICS.

This leads us up to the matter of an emergency case for work upon the railway, and how to prepare the same so as to be ready to-day, or next week, or any time, for the hour of need. In preparing such packages compactness should be the aim.

Emergency Case.

The emergency case should contain everything necessary for dressing and operating on any case that may be met with, and by this is meant such operations that demand immediate attention in order to save the life of the individual. It is remarkable how few instruments one can ably get along with, and the longer one is operating in general surgery the more convinced will one become of this fact. It is needless to say that all the dressings and materials to be used in or around the wound must be sterilized, and as this procedure takes time it must be done beforehand, and carried in sealed packages in the emergency case.

Now for a description of the case (see Fig. 19).

An eight by ten or twelve-inch telescopic bag is by far the most useful carrier. Named in the order of probable need of the articles, place within the bag the following:

Esmarch rubber bandage.
Bichloride tablets.
Spirits of turpentine.
Saturated solution of carbolic acid.
Formaldehyde.
Soap.
Nail brush.
Razor.
Aristol.
Boracic acid.
Iodoform gauze, five or ten per cent.
Plenty of plain gauze (having the gauze cut in small squares to save time and handling).
Plain gauze bandages.
Muslin bandages.
A few plain thin board splints.
Scissors.
Anatomical forceps.
Small spoon curette (for cleaning out the bottom of wounds).
Several pairs of hæmostatic forceps.
Scalpel.
Small saw.
Rongeur bone forceps.
Bone elevator.
Needles.
Silk.
Silkworm gut.
One or two broad binders of heavy muslin, for chest or abdominal injuries.
Safety-pins.
Hypodermic syringe.
Morphia sulph. gr. $\frac{1}{4}$, strychnia sulph. gr. $\frac{1}{30}$, and nitroglycerin gr. $\frac{1}{100}$ tablets.
Whiskey.
Anæsthetic and mask.
Silk or gum-elastic catheter.
Fountain syringe.
A few towels.

In the bottom of the case place a shallow pan made to fit the case, for an instrument tray.

As remarked, a number of these articles must be carried in sterile packages. How best can we do this? Gauzes can be folded into squares and wrapped in close woven cloth, pinned snugly, and the package so made up placed in a sterilizer for an hour. When removed they are wrapped and sealed in waxed paper, and the contents are safe for any emergency in the future. The gauze can

also be placed in bottles, the mouths plugged with cotton, and sterilized in the same manner (see Fig. 20). The latter is preferable, but more bulky and more apt to become broken in transportation. Silk is wound on spools or pledgets of cotton, placed in stout test-tubes, plugged with

FIG. 19.—Surgeon's Emergency Case, showing contents as named in the text.

cotton, the whole package placed in a sterilizer, and after removal may be kept indefinitely, or they may be kept in alcohol after removal from the sterilizer (see Fig. 21). It is well to put but one size in a tube or bottle, and to have the silks in lengths of about eighteen inches, thereby saving time and handling when being used. The bandages and towels can be wrapped in muslin as in the case of the gauzes, sterilized, and wrapped in waxed paper. Needles

are best kept in a small phial of alcohol. The Esmarch bandage and catheter should be sterilized in boiling water and wrapped in sterile oiled silk. The instruments (see Fig. 22), after being boiled in a one-per-cent carbonate of soda solution, and dried with sterile towels, may be

FIG. 20.—Sterilized Gauze Packages, plugged with cotton.

wrapped separately in waxed paper or oiled silk, the nature of the instrument being readily felt through the material, and only the ones wanted unwrapped at any time.

Now this is an ideal emergency case, and although appearing to be overdoing the matter in point of cleanliness, there will be found much satisfaction as well as some pardonable pride in having such an outfit to work with.

Many depend upon throwing a few things in a bag at the time of a call, and too often get to the scene and find that something, perhaps the most important, is missing.

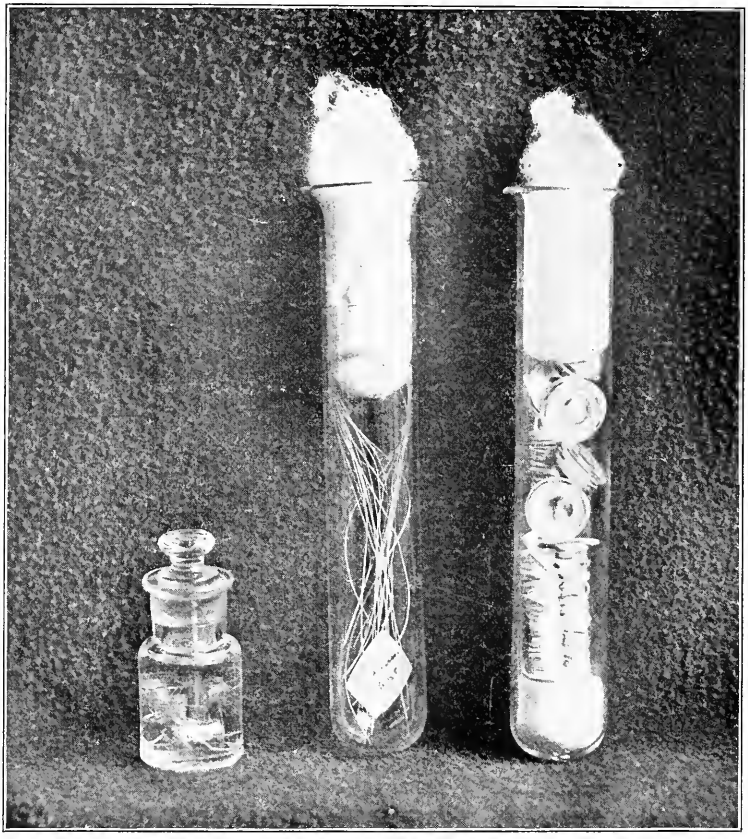

FIG. 21.—Sterile Packages of Silk, Silkworm Gut, and Catgut.

One cannot afford to take the chances of anxiety and chagrin such a mishap would cause, for any one will have plenty of leisure when these packages can be prepared for later use. Then it is gratifying to arrive at a case, the details of which were perhaps unknown before-

hand, and to find one's self fully equipped to meet the requirements.

As railway and street accidents are not every-day occurrences, and the locking up of several instruments that may be needed is not always desirable, the latter need not be kept in the box; but if this plan be adopted,

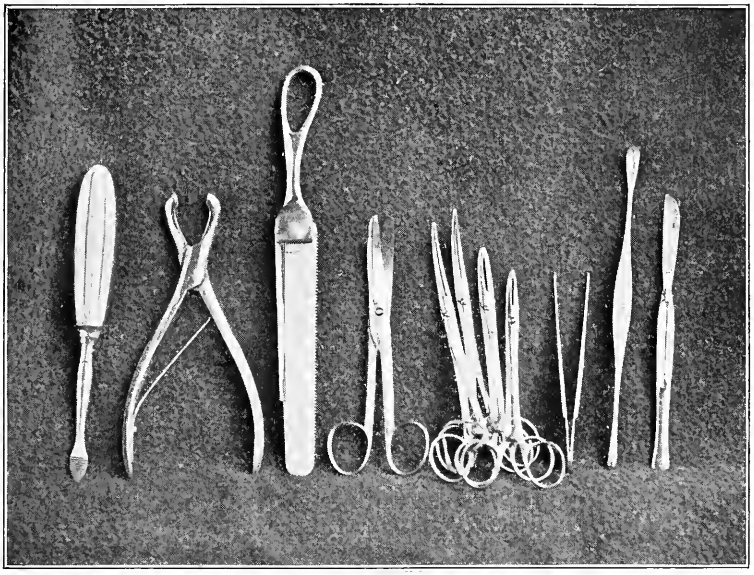

FIG. 22.—The Instruments Necessary for an Emergency Case, named from the right-hand end, viz.: scalpel, curette, anatomical forceps, hæmostatic forceps, scissors, saw, rongeur bone forceps, and bone elevator.

make a list of these and place it upon the case, where it may be referred to when making up the package, so that none be forgotten in the hurry of departure.

When they are thus taken without the necessary time for sterilization, the carbolic-acid solution, 1:40 or 1:60, or a one-per-cent solution of formaldehyde can be utilized for their immersion.

Water, the only thing left to obtain, is everywhere accessible, and if means are at hand for heating it rapidly, that should of course be done. If a locomotive is near by, live steam can be turned into a basin of water and heat it very quickly, or hot water, drawn directly from the boiler of the locomotive, is practically sterile and highly satisfactory.

Sterilization.

Now as regards the sterilization. There are many admirable and convenient forms of apparatus, but all are

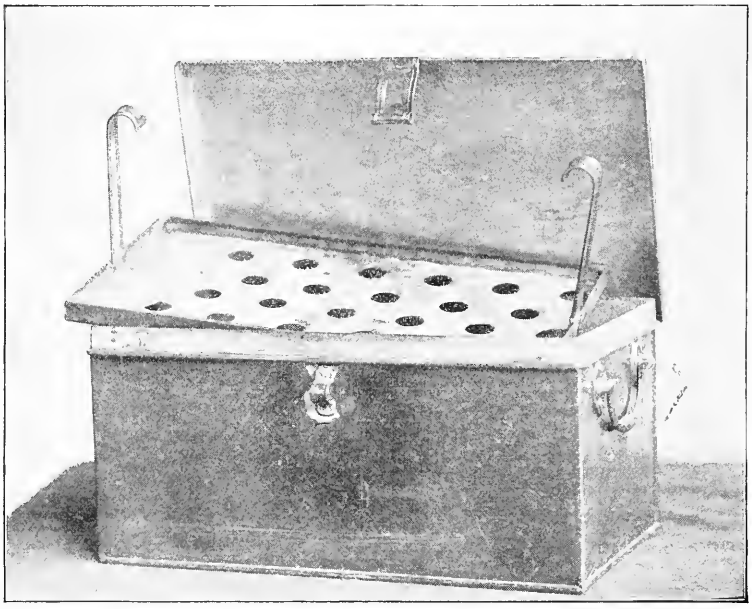

Fig. 23.—The Author's Sterilizer, showing inside tray.

not always very portable. A very good one can be made as follows (see Fig. 23): A copper or tin box, eight by twelve by six inches deep, with a lid hinged and flanged

to fit the box snugly, contains a perforated tray resting on corner pieces fastened inside the box about two inches from the bottom. For use, pour water to the depth of an

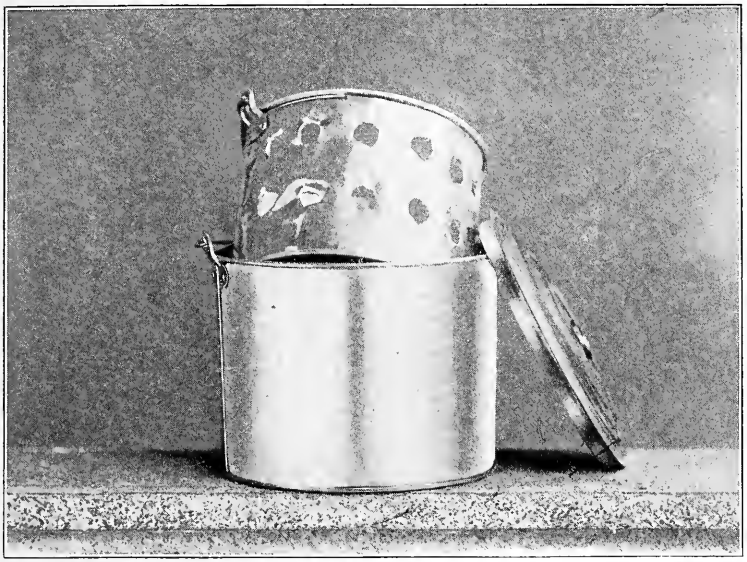

FIG. 24.—A Twenty-five-Cent Sterilizer.

inch into the box, fill the tray with the articles to be sterilized, shut the cover, place the box on a gas, kerosene, or coal stove, or even over an alcohol lamp, and by boiling the water perfect sterilization of the contents of the box is obtained. For transportation, the box can be made to serve as a carrier for all the dressings and instruments necessary for any ordinary surgical operation, thus making a complete, compact arrangement, practical, cheap, and satisfactory.

A twenty-five cent sterilizer can be made by the purchase of two tin pails, the smaller to pass freely into the larger, leaving a space in the bottom. A bridge is placed

at the bottom of the large pail for the smaller to rest upon, and the inside pail perforated with holes (see Fig. 24).

In lieu of this, an ordinary steamer or kitchen pail can be made to fill the bill in case of necessity.

Of course, these are only suggestions to enable one to grasp opportunities available in times of emergency.

The latest, and certainly very valuable, addition to the list of disinfecting agents is formaldehyde, which has

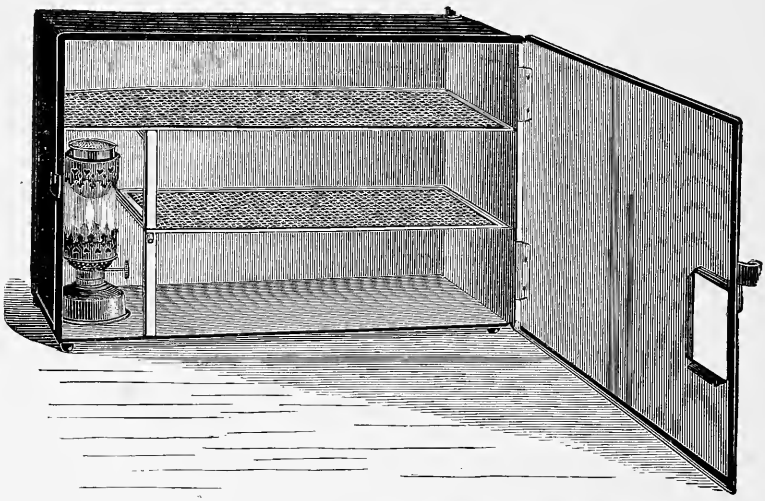

FIG. 25.—Schering's Formalin Sterilizer for Instruments.

been found very effective, consuming less time, and perfectly harmless to the most delicate instruments or fabrics. It is, therefore, of especial advantage for the disinfection of instruments, and inasmuch as the process can, by proper apparatus, be made complete in ten to fifteen minutes, it is certainly to be recommended. As dry heat of the requisite temperature, as well as boiling in

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water, has a deleterious effect upon all instruments, any approved method of obtaining sterilization without this disadvantage is decidedly to be preferred.

The best way to employ the agent is by means of a formalin lamp, by which paraform pastils are vaporized in a closed chamber of proper capacity. Schering's lamp, used in a cabinet as seen in Fig. 25, is a very convenient and successful way of obtaining results.

The cabinet is 18 inches wide, 11½ inches high, and 8 inches deep; hence it has a capacity of 1,666 cubic inches, *i.e.*, a little less than one cubic foot. The interior is divided into sections by shelves of wire netting, which allows the gas to reach all parts of the instruments or loosely woven materials placed upon them. After the requisite paraform pastil of one-third gram (five grains) has been put in the lower receptacle (the upper cup is not used with the sterilizer), the lamp is set in its compartment and lighted. The sterilizer is then closed, and in fifteen minutes the contents will be thoroughly sterilized. A small piece of glass is inserted into the door to permit the flame of the lamp to be seen. The outlet on the top of the sterilizer will facilitate the escape of the gas when the process is complete. Quickly handling the contents with sterile hands, and wrapping them well in sterile packages, as noted in the ordinary methods described above, they may be kept for an indefinite period perfectly sterile.

The soft-rubber catheters and Esmarch bandages may also be treated in the same manner without detriment to the material.

Anæsthetics.

The question of an anæsthetic now comes up, as it is often necessary to employ this agent before any proper inspection or dressing of an injury can be made, while for operation cases it is demanded if the individual is conscious. No fear need be entertained in its use when the condition requires the same, for it is an assured fact that such an agent acts favorably in cases of shock, and many patients improve under its influence. The pain and mental distress are relieved and a general stimulant effect is produced.

Choice.

The question of choice of anæsthetics is one that each surgeon should settle in his own mind from study, observation, and experience. Ether, chloroform, and the mixtures of these are recognized and employed the world over. Each has some advantages and some disadvantages, its advocates and those adverse to its use. It is very advisable to get acquainted with them all, but not to the extent or purpose to use them indiscriminately. There is no doubt but that any drug capable of producing unconsciousness is dangerous. The fact that one of the above-named drugs possesses this dangerous principle more than the others is not true, aside from certain modifications which have to be considered when they are to be used in conditions of disease of certain vital organs.

In railway surgery there is no reason why one should not employ the same anæsthetic that he uses in daily practice. It is very advisable to get thoroughly familiar with

one anæsthetic, and use it in all cases save as above noted, where exceptions have to be made to comply with the results of scientific research and experience.

Vienna Anæsthetic.

The author has employed for many years the Billroth Vienna mixture, and finds that it acts admirably in all conditions in which any such agent is to be used. Its chief advantages lie in its rapid action, the small amount used, and the simplicity of apparatus. But few cases of prolonged effect, vomiting, and other disagreeable symptoms, are noted to follow its use. The author has observed over two thousand cases without a death. The formula arranged by E. R. Squibb, in whose laboratory the mixture is prepared according to the author's directions, is as follows:

℞

Ether, U. S. P.	11	parts by weight.
Absolute alcohol, U. S. P.	12	" " "
Chloroform, U. S. P.	77	" " "

Mix.

In railway injuries, as well as in many cases of general surgery, an anæsthetic is desired which will act promptly and completely in order to overcome excitement and violent struggling which become a possible serious matter in compound and comminuted fractures, where the bones may do additional damage to the soft structures by such motions. Here this anæsthetic acts well, inasmuch as narcosis is accomplished speedily and completely, and without being disagreeable to the senses of the individual.

The method of administration of the Vienna mixture is an important matter, to insure promptness and safety,

and is as follows (see Fig. 26). Employing the Esmarch drop bottle and mask, the latter should be made of a tricot cloth, or one of rather coarse mesh of large-fibre goods, which allows plenty of air to pass through, yet retains considerable of the anæsthetic in the fibre of the cloth. Beginning with a few drops, and increasing this rapidly

FIG. 26.—Proper Method for Administering the Vienna Anæsthetic.

until the mask is saturated, and keeping it so for a few moments, will be followed by a very prompt and satisfactory anæsthetic condition. The subsequent administration is kept up by frequent dropping of the anæsthetic mixture on the mask according to the depth of the narcosis. Upon complete removal of the agent the patient comes rapidly out of the condition.

As in all anæsthetics, especial care should be given the

tongue, and in the majority of cases this will have to be grasped by forceps to prevent its dropping back into the throat and closing the glottis.

Subsequent to the narcosis it should be observed that the head be kept low for at least an hour or two. Several cases of fatal syncope are recorded as resulting directly upon the person's head being raised to accelerate the ejection of vomited matter, or to permit him to take a drink.

CHAPTER VII.

CUTS, BRUISES, BURNS, AND SCALDS.

Among railway employees scarcely a day or an hour passes by without some one of the army of trackmen, switchmen, brakemen, repair gangs, or other of the general class, receiving some kind of a wound or bruise. Because of constant handling of irregular heavy pieces of material and continual going about among masses of new and old structures, few escape the necessity of caring now and then for some minor injury.

It is conceded that even such slight injuries may easily become serious through bad handling or the crude attentions frequently given them by the man himself. Therefore, the employee should be made to realize the importance of attending to every abrasion or wound in a proper way, that there be no bad results by reason of negligent first-aid practised either by himself or his fellow employees.

Cuts.

Cuts are usually contused, although in the railway shops an occasional incised or "split" wound is seen. The "emergency packet" contains materials for dressing such injuries, and they should be so applied. The moments directly following a cut, with blood oozing freely, are the moments when, if a good antiseptic dressing be applied and held firmly until coagulation occurs, the wound may be

kept for two or three hours practically aseptic. At the moment the blood ceases to ooze, the germs from the skin or clothing may make ingress, and this is why dressing during bleeding tends to check this and preserve asepsis.

Such cuts, if attended to with as much care as would be given any wound, heal rapidly without complications and with hardly any loss of time to the individual.

Bruises.

Bruises are more severe for the reason that the subcutaneous inflammatory process, or cellulitis, which supervenes immediately upon the injury, serves to prevent the free use of the part because of the consequent pain and swelling.

A slight bruise will recover of itself in a few hours; one more severe will also heal if no complications exist or no actual destruction of even small areas occurs, or if no free blood escapes subcutaneously. If so, an abscess may develop through the agency of skin sepsis, which, if not relieved, will, by burrowing, give rise to no end of trouble and to a considerable loss of time to the individual. Such a course would be marked by an increase in the local tenderness and pain, and which should be the guide for a free incision into the part to allow free drainage and a washing out of the cavity with dioxide of hydrogen.

In the minor cases hot fomentations for a few hours will almost entirely relieve the pain and inability to use the bruised part.

This application may also be made to the septic form, especially after being opened, to hasten the separation of any portions of disintegrated tissue.

In these forms of bruising, with or without a break in the skin, care should be taken to clean the part thoroughly, using the spirits of turpentine, or some other agent, and subsequently an antiseptic solution. By so doing the danger of sepsis entering into the inflamed area from an infected skin is removed, and the opportunity given for an otherwise possibly severe condition rapidly to improve.

Burns and Scalds.

Burns and scalds are frequently seen, being caused by contact with the steam and hot water of the locomotive. From those slight in extent to those involving an entire extremity, they may be considered serious directly in proportion to the extent of surface which they cover.

Beyond the signs of these, visibly noted, shock is present when a considerable surface is implicated. Fatality ensues only in those cases in which, through explosion of the boiler or the blowing out of a cylinder, a quantity of steam and hot water sufficient to scald the greater part of his body is poured over an individual.

The treatment of these conditions when the outer skin is broken, or will soon be shed by reason of large blisters being formed, is the application of the old-time carron oil, equal parts of lime water and olive or raw linseed oil, which is made antiseptic through a previous sterilization, or by addition to it of carbolic acid, formalin, or bichloride solution, in just sufficient quantity to effect the purpose. Plain gauze is preferable to cotton to apply the oil with, as it may be more easily removed. Plenty of gauze should be used, and over all thick layers of cotton to make a bulky,

warm absorbent dressing. As granulations appear, the oil may be discontinued, and aristol, dry or in form of an ointment, applied. In cases of simple scald, with a sound skin remaining, the application of a saturated solution of bicarbonate of soda is followed by prompt relief.

It will usually be necessary to give an anodyne for the relief of pain, and by administering hypodermics of morphine this condition should be thoroughly controlled, thus insuring absolute rest.

In the very severe cases, the shock and the question of transportation should be treated in the same manner as directed in the chapter on the primary treatment of the wounded.

As always taught, care should be taken in the healing of these conditions to prevent cicatricial contractions, and this is best done by passive motion well and frequently directed. If cicatricial contractions show a tendency to occur, an incision should be made in the skin at places where the strain seems to be the greatest, and the part so incised should be retained in complete extension by splints and firm dressings until healed. Skin grafting may have to be resorted to.

CHAPTER VIII.

SPRAINS—DISLOCATIONS—DISLOCATION OF THE SHOULDER; OF THE HIP.

Sprains.

Sprains of the various joints of the body, and especially of the ankle and back, are quite frequent in railway service on account of the proneness of individuals to jump from a train before it has come to a standstill. They slip, lose their footing, and a wrench of the joint occurs as a result.

As a matter of fact, such injuries in the movable joints are aborted dislocations, the force of the fall driving the articular surfaces far enough aside from their normal relations to stretch or partially to rupture the fibres of the ligaments holding them, and then, as the force diminishes or recedes, the bones resume their normal relations. The result is an immediate inflammatory condition in which an abundant effusion of serum into the joint occurs, causing a marked swelling to appear, and usually there is some outpouring of blood in the cellular tissues in the immediate neighborhood. Pain is marked from the first, and an inability to use the joint usually comes on rapidly.

Diagnosis.

The diagnosis is usually clearly made out from the history, appearance of the condition, and absence of any of

the markings of a fracture. If seen after the swelling has assumed prominence, with loss of function and pain, much care must be observed not to overlook a fracture or dislocation. If much doubt exists, it is better to give an anæsthetic and make a thorough examination at the first instance.

In sprains of the back some difficulty may be met with in managing the cases satisfactorily. As remarked in another chapter, it requires quite a force to produce a true injury to the spinal cord, with which condition a sprain of the back is most liable to be confounded. The history of the injury and the appearance of the individual, as well as the position the patient assumed when first seen, or even thereafter, will serve to lend aid in making the diagnosis. The patient always favors the muscles of the back and is careful not to put these in contraction, yet he is perfectly able to use them. In associated spinal trouble local tenderness is not always prominent, while disturbances of sensation and motion are to be observed.

Prognosis.

The prognosis in cases of sprains will be along the same lines as in simple fractures of the same locality. As far as function is concerned, much depends upon the extent of rupture of the ligamentous structures; but as to the length of time the individual will probably be disabled, it will not vary far from that intervening in a case of fracture, although often it may be longer.

Treatment.

As to treatment, it is best to use very hot fomentations at the first instance, coupled with complete rest and elevation of the part injured. These hot fomentations may be of water, or of some light counter-irritant, as lead and opium lotion, or turpentine. A firm, soft bandage should be simultaneously applied, which with frequent changing will assist greatly in the absorption of the effusion and consequent reduction of the swelling.

As soon as the primary swelling subsides, a fixed dressing should be applied in order to secure the best result. Either crinoline, the silicate of soda (water-glass), or the plaster-of-Paris dressing may be employed. First wrap a bulky cotton bandage over the joint, then a fixed dressing material is firmly applied over this. An elastic padding is thus secured which prevents any undue pressure in case the parts swell subsequently. If such swelling takes place, the mould should be at once slit up and readjusted in its place by a roller bandage, or a new dressing applied. Always look out for this possible condition underneath a fixed dressing, and relieve the swelling before dire results from such pressure occur.

In case of sprain to the back, a plaster-of-Paris jacket or a stiff corset should be applied, and the patient be gotten up and around as soon as possible, that he may not develop into a neurasthenic.

The length of time that these fixed dressings are allowed to remain depends upon the symptoms accompanying the condition. As soon as the patient ceases to complain of pain in the part, the dressing can be removed, and

if he is not entirely able to use the joint without discomfort, an elastic woven "cap" may be used, which will in all probability permit him to go about as usual.

Dislocations.

Dislocations may be considered among the minor accidents in railway service, for it is well conceded that but slight force is necessary to produce such an injury. Stumbling over the *débris* in a yard, or among some of the superstructure of a roadway, and falling to the ground may be the cause of a simple dislocation, although it may be present as a complication of other injuries inflicted by severer force than mere falling. Whenever or wherever seen they present as usual.

Diagnosis.

A marked deformity in the joint and limited motion, attended with pain, are the general diagnostic points. Absence of preternatural mobility and of crepitus excludes fracture.

It is only when associated with a fracture at or near the articulation which is luxated that dislocations give any trouble in the matter of diagnosis. It sometimes happens that through the agency of the powerful forces of the railway, the entire articular end of a bone is thrust through the soft parts, thus becoming a compound dislocation. These dislocations may be easily reduced, but are not only extremely difficult to retain, but also require much care to keep aseptic.

The principal dislocation encountered in railway service is that of the shoulder-joint, more rarely of the hip. The injuries of this class in the ankle and elbow are

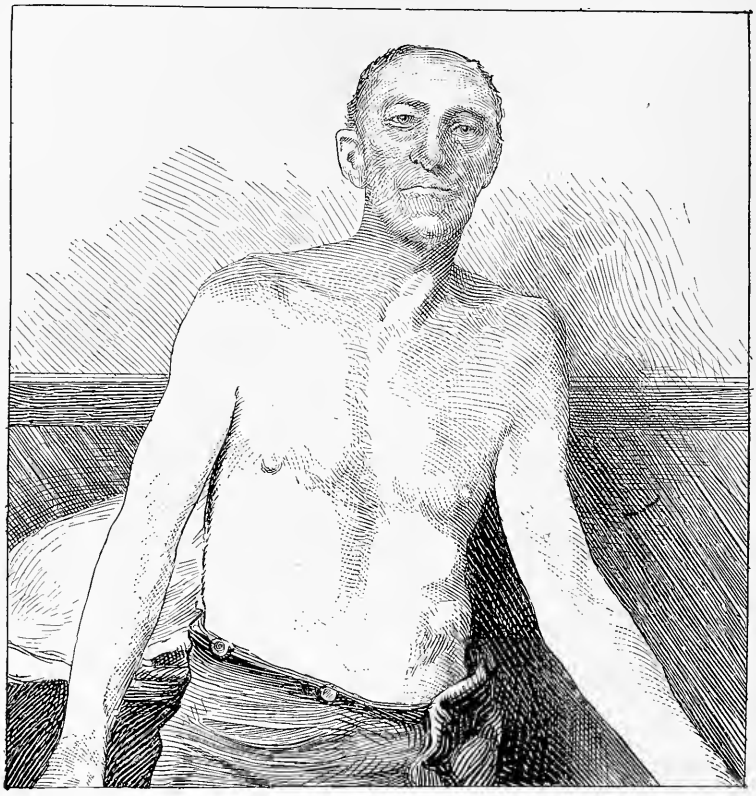

FIG. 27.—Appearance of a Patient with Dislocation of the Shoulder-joint.

nearly always associated with a fractured process which permitted the luxation to occur, and these are to be considered as fractures.

Treatment.

The reduction of a dislocation is accomplished along the lines given by general surgery, which is, in the main,

extension combined with manipulation in the direction indicated to return the head of the dislocated bone into its normal position.

Shoulder-Joint Dislocation.

As to the special points regarding shoulder-joint dislocation, it may be said that at times it is the most difficult

Fig. 28.—Reduction of Dislocation of Shoulder-joint by Kocher's Method; first position.

to recognize, especially in fleshy individuals. A fall, the inability to raise the arm outward from the body, the absence of the rotundity of the top of the shoulder, the inability to get the elbow close to the side of the chest, while the palm of the hand usually faces forward, are all diagnostic signs of the greatest value (see Fig. 27).

In the reduction of this lesion there is no better method than that of Kocher, which will usually quickly

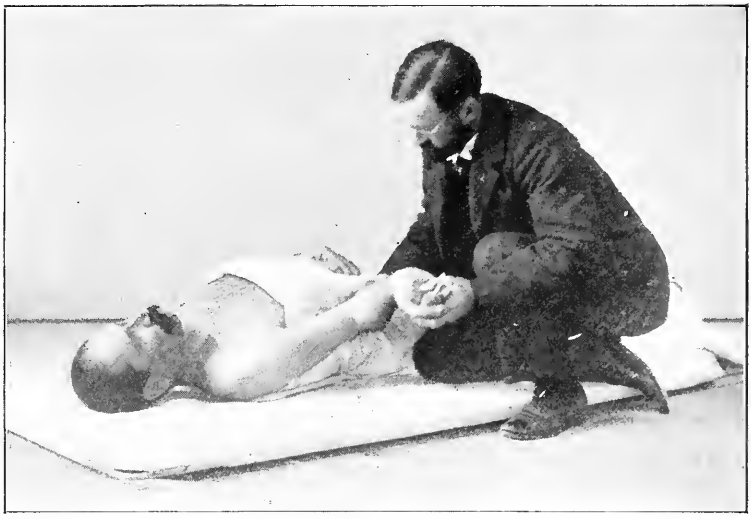

FIG. 29.—Kocher's Method, Second Position, the hand being carried outward, and the elbow retained close to and upon the chest.

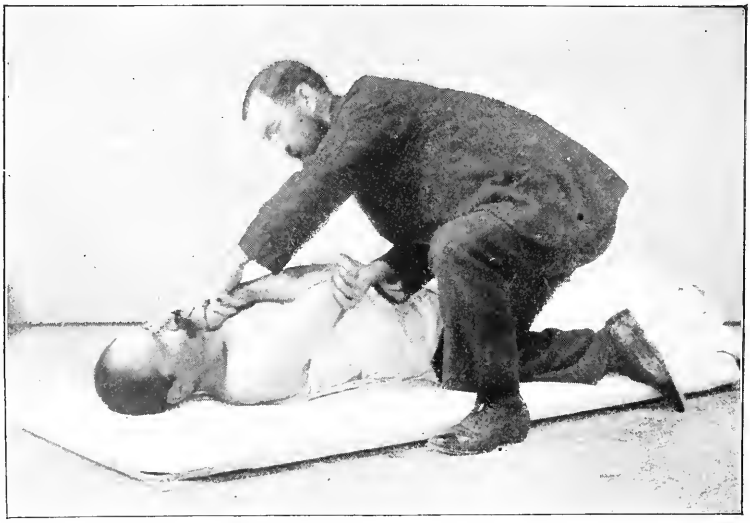

FIG. 30.—Kocher's Method, Third Position, by carrying the hand from the second position to and across the chest, the elbow following it upon the chest.

succeed, and that without the use of an anæsthetic. It is performed as follows;

Place the patient on the floor on his back, and flex the forearm on upper arm (see Fig. 28). Then holding the elbow close to the side rotate the forearm outward until the hand reaches as near the floor as possible (see Fig. 29). Keep the whole arm thus as nearly horizontal as possible, when by throwing the hand to the opposite shoulder (see Fig. 30) the head of the bone rolls into place.

This method answers for subglenoid or subcoracoid, and is also successful in subclavicular dislocations.

In a few cases the older method of extension of the arm, with the heel in the axilla, will be found necessary, although in this procedure an anæsthetic is indispensable.

Dislocation of the Hip-Joint.

Dislocation of the hip-joint is not commonly met with in railway practice. As it is an injury of serious import, and if uncomplicated easily relieved, it is expedient to be prompt in its recognition and reduction before the individual is transported farther than the nearest shelter.

This dislocation may be caused by any severe fall or blow, where the force is brought to bear upon the hip-joint in an irregular way, and may be present as a complication of other injuries.

Symptoms.

As to symptoms, there is an utter inability to use the extremity, with pain in the region of the hip, increased upon efforts at motion, and deformity will be prominent.

Frequently the patient will tell that he felt a snap as the bone slipped out of place.

The dislocation may occur either upward and backward, or downward and forward, the former occurring in seventy-five per cent of all cases.

In the upward and backward dislocation, in which the head of the femur rests upon the dorsum ilii, the leg is found shortened an inch or more and the foot inverted, adducted, and lying across the opposite instep or ankle (see Fig. 31). The head of the bone can frequently be felt in its abnormal position, the trochanter reaching above Nélaton's line (a line reaching from the anterior superior spine of the ilium to the tuberosity of the ischium). The entire leg and foot will be quite rigidly fixed and difficult to move in any direction.

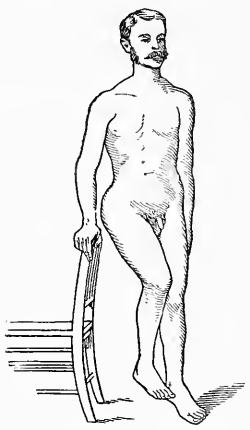

FIG. 31.—Appearance of a Patient with Dislocation of the Hip-joint (upward and backward).

If the femur be luxated downward and forward into the thyroid foramen, the thigh will be abducted and partly flexed, with eversion of the foot and some lengthening of the leg. The hip will be flattened and the inner side of the thigh, at its upper part, will be hard and prominent. Rigidity and pain will be very marked, causing total helplessness of the patient. The author recently attended a case of the above form of dislocation, in which both hip-joints were simultaneously luxated. The signs and symptoms given above are an exact portrayal of those exhibited by

this patient. Both dislocations were easily reduced by the method noted below.

When the head of the femur is thrown upon the pubis the case will present the same features as when luxated downward and forward, save that the head of the bone may be easily felt over the superficial pubis.

Diagnosis.

In the diagnosis of dislocation of the hip-joint care must be taken not to confound it with an "intracapsular" fracture of the neck of the femur, either complete or impacted. In the latter injury there will be shortening of the extremity, and usually inversion of the foot. Rigidity of the thigh may be present owing to firm contractions of its muscles, and the trochanter may be found reaching above Nélaton's line. If crepitus is present it will aid in the diagnosis, although it may be absent or muffled. Many injuries of joints give a grating feeling to the touch when palpated or manipulated, which is very similar to and often mistaken for crepitus. In impacted fracture we will not find crepitus. A knowledge of the age of the individual, and the manner in which the blow or fall was received, may be of aid in establishing a diagnosis.

If the person is over fifty years of age the evidence will be strongly in favor of a fracture of the neck of the femur. Under that age the bones are less brittle and more liable to dislocation than fracture.

If the person has fallen directly upon the hip, a fracture is more liable to result than in case the fall has been received in some other way, and in which the thigh bone

has lifted its head out of the acetabulum through the force of leverage.

The use of an anæsthetic is indispensable, inasmuch as it will give every opportunity to diagnose the condition, and permit a dislocation to be reduced while the patient is under narcosis. Care should be exercised in the amount of force employed in the manipulations while the patient is under the anæsthetic until the condition is clearly made out, for if fracture should exist, its fragments, under motion, might do damage to the surrounding soft parts. Moreover, if the condition should be one of impacted fracture, the fragments would be separated, not altogether a proper thing to have happen.

Treatment.

To reduce a dislocation of the hip-joint an anæsthetic is a necessary adjunct.

When the femur is dislocated upon the dorsum ilii, proceed as follows: Flex the leg upon the thigh and the thigh upon the abdomen as far as it can be, and in so doing carry the knee well to the opposite side of the median line of the body (Fig. 32). Then carry the knee outward, gradually extending the leg and thigh (see Fig. 33). The head of the bone will thus be made to ride upon the edge of the acetabulum, and slip into its cavity.

When the dislocation is forward and downward the flexed extremity should be carried as far toward the opposite side of the body as possible, in the same manner as above outlined and seen in Fig. 32, then the knee firmly turned in while the extremity is being gradually ex-

FIG. 32.—Reduction of Dislocation of the Hip-joint (upward and backward), first position, flexing the knee upon the abdomen.

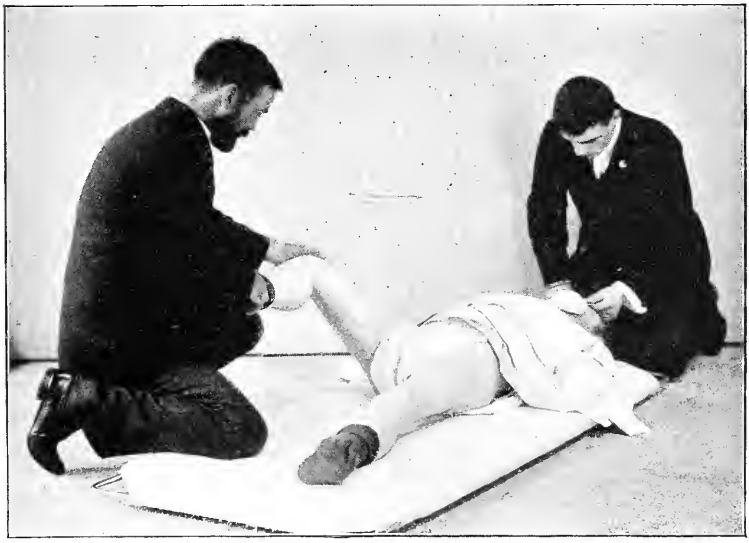

FIG. 33.—Reduction of Dislocation of the Hip-joint (upward and backward), second position, carrying the knee outward while extending the entire extremity.

tended (see Fig. 34). It may be necessary to make combined extension by a towel around the thigh, by which outward traction is made during the execution of the above manipulations.

In obstinate cases it may be necessary to make forcible traction in the line of the femur to release the head of the bone from the hollow into which it may have been drawn.

FIG. 34.—Reduction of Dislocation of the Hip-joint (downward and forward; first position same as in Fig. 32), second position, carrying the knee across the median line of the body as the extremity is being extended.

It should be remembered that the leverage obtained by these procedures is very great, and its power must not be underestimated, as a fracture of the thigh might result from carelessness in this direction. It is not the force which is employed that reduces the dislocation, but the execution of manœuvres that will carry the head of the bone toward and upon the edge of the acetabulum, when

the elasticity of the surrounding structures will draw it into the cavity.

After reduction has been accomplished, if the person has never before sustained a like injury, and is strong and robust, there is no need of applying any fixed dressing; simply restraining the person from bearing full weight upon that extremity for a few days is all that will be necessary. If the individual is of advanced years, or the muscles are flabby, it is well to apply a bandage for a few days or a week, using a broad belt of strong cloth to envelop the whole pelvis and hip. Confinement to bed is unnecessary, the use of crutches should be permitted, and some swing should be given the joint. Passive motion should be instituted within a day or two, and freedom given to the joint as soon as the person can walk upon it without pain or sense of insecurity.

Very few cases result in any permanent disability, although aged or debilitated persons are apt to sustain a re-dislocation upon very slight provocation.

Other Points and After-Treatment in Dislocations.

It may be necessary in case of a compound dislocation, and may be wise in any difficult case, to suture the torn ligamentous structures across the reduced extremity, so that it may be firmly held in place. Such a wound should always be drained, and by packing, forced to heal from the bottom to the surface.

In compound dislocations, or in those complicated with a fracture close to the articular head, it very frequently becomes necessary to advise a resection of the head of the

bone, for the reason that not only will it be a difficult matter to get the head of the bone in its proper relation, and to keep it there, but the subsequent callus and adhesions consequent upon the repair of the parts will so interfere with motion as to reduce the latter to a useless degree. When this is imminent, therefore, do not hesitate to do a resection and thereby obtain a good result in place of a useless extremity.

After reduction, the part should be supported, but passive motion begun at once and kept up assiduously. In simple dislocations the ligaments are only stretched, and soon recover their tone. To allow the part to become disused for a time permits inflammatory exudate to pour out and stiffen the articulation to such an extent as greatly to hinder its complete recovery. From the moment of reduction, therefore, a joint should be supported, but left mobile, and use given to it, gradually increasing from a careful beginning to full motion in a day or two. The application of liniment is of little value, but may be recommended as a counter-irritant to the part.

Prognosis.

The prognosis, as to restoration of function, always remains in doubt, and should be guarded. In shoulder-joint dislocations, full and complete motion is usually obtained in the young and rugged. In older persons the inability to raise the arm to a right angle generally remains permanent.

In the hip, much better results are found to ensue in regard to function. When complicated with fracture, the

prognosis lies nearer the door of the latter condition, as the fracture is the more serious injury of the two.

In uncomplicated dislocation, three to four weeks should find the motion as completely recovered as will be probable in the case.

Atrophy, and even paralysis, are not infrequent as a direct result of the dislocated bone doing damage to the nerve trunks near by. In cases slow to recover, therefore, efforts should be made to forestall the possible contingency of such conditions.

CHAPTER IX.

SCALP AND FACE WOUNDS.

Wounds of the Scalp.

Uncomplicated scalp wounds are not particularly frequent on the railway. We meet them, however, in conjunction with other injuries, either directly associated with the scalp wound, as a fracture of the skull, or with other wounds remote from this point altogether.

Causes and Variety.

The cause is usually a fall from a train or car.

In variety we meet nearly all, save the true incised wound; but in the majority of cases, a ragged, contused, or lacerated wound is the one present. In severity they do not necessarily follow the apparent degree of force which has produced them, for the surface of the body against which the head strikes has much to do with the extent of the laceration. A smooth ground or a flat broad surface would make but a slight wound compared with the impact against a sharp or irregular surface, independent of the force or the distance of the fall.

Signs and Symptoms.

These wounds may be simple and present no bad appearance, or, as is usually the case, they may be filled

with dirt and gravel, with the adjacent skin scraped and bruised, or distinct wounds in other portions of the scalp may coexist. A person falling with enough force to be rolled over and over among rough stones or superstructure will suffer from very ragged wounds, or from a multiplicity of cuts and scratches.

As to the signs of a scalp wound, they are apparent enough at first sight. The parts being so vascular, hemorrhage is certain and frequently profuse, marking at once the site of injury.

As to symptoms, pain and dizziness are present to a degree varying with the extent of injury, but seldom is consciousness lost. A slight faintness is at times observed, but it passes quickly over. None of the functions of the body is disturbed, and the individual can care for himself in every way. These cases always need especial attention in examination, for knowing the nature of the force producing the injury we are aware that, though apparently uncomplicated in any way, there may be associated with it the graver one of fracture of the skull beneath. Whether the patient is conscious or not, therefore, we should carefully examine for that possibility. The presence of a comatose state may or may not be caused by it, but we must be certain as to that.

Shock is not present as a result of simple scalp wounds, so that its presence denotes either severer injury to the structures below, or other complications, and should be the signal for looking carefully into the matter.

Treatment.

As to the treatment of these wounds, the directions given in a previous chapter as to the care of the wounded in general, will cover nearly all the ground. The hemorrhage is at times very copious, especially when the temporal arteries are severed, and it may be necessary to apply a ligature to a spurting vessel. Usually, however, at the most, the application of a pair of hæmostatic forceps, left on while the wound is being cleaned out, will be found to check the bleeding.

There is, of course, the necessity of cutting the hair close all about the wound, and it is far better to shave, and to shave either a wide margin or the entire scalp, otherwise it is almost impossible to keep the scalp clean. Foreign bodies, and splinters of wood, and gravel, are very prone to stick closely to the scalp and periosteal structures, requiring particular care to get rid of all of them.

After a careful examination as to the possibility of the presence of deeper injury, the dressing of the wound may be proceeded with. Here particular stress is to be laid upon the points of good drainage by tents of gauze, and the omission of sutures of any kind. If the wound be small in extent it certainly will not need any stitches; but if large, so that a flap hangs down, or cannot by gentle pressure be made to hold itself in proper position, it is permissible to use one or two stitches purely for support, leaving the angles open. The great frequency of the subsequent feature of sepsis, a phlegmon developing under a tightly closed scalp wound, is the reason why it is urged not to do this. A firm pad of gauze, well laid, will usually do

all that a suture will do in supporting the edges in apposition, and is far safer. Then, dusting the wound well with aristol, covering with an absorbent pad of iodoform and plain sterile gauze, and over all a firm roller, and the

FIG. 35.—A Crinoline Skull Cap for Protecting Dressings upon the Head.

application of a crinoline bandage completes the dressing. The crinoline, applied while wet, soon dries, making a firm moulded cap. In fact, this is an important part of the dressing, as otherwise it is almost impossible to keep it upon the head firm enough to prevent the dressing becoming loosened and displaced, thereby giving admittance to germs from the outside (see Fig. 35).

As to the after-care, all cases of scalp wounds, unless unmistakably simple, should be kept under observation for several days, in the possible event of secondary complications, either from development of conditions overlooked or from sepsis uncontrolled. As some headache usually supervenes, rest should be enjoined and a good catharsis given. Daily dressings should be instituted until clean union is assured, when more infrequent redressings are permissible.

In cases which are not destined to do well, the first redressings will show a redness, or after twenty-four or forty-eight hours a throbbing pain in the parts with signs of inflammation will come on, indicating the presence of pus somewhere confined about the wound. A free opening into this, washing out with dioxide of hydrogen, and free drainage of the cavity, indicate the line of treatment, covering as at first with a copious absorbent, antiseptic dressing, to take up the discharges.

Wounds of the Face.

Wounds of the face are to be considered in about the same light as those of the scalp. They are somewhat more frequent, owing to the more exposed surface. Always bloody, ragged, but usually minor in degree, they are frequently complicated by a fracture, or crushing in of the facial bone beneath the site of the wound. If uncomplicated, the result is usually favorable.

Treatment.

The treatment is similar to that followed in the case of scalp wounds, save that where the edges cannot well be approximated the application of a few sutures may be employed in order to get a better æsthetic result. In such a case very fine needles and silk should be used so that the surface will present the minimum amount of marking; or the subcuticular stitch should be employed. There is less frequently a tendency to the burrowing of pus accompanying infection in face wounds than in the case of wounds of the scalp. The stitches should be removed as early as possible—usually in twenty-four to forty-eight hours.

Wounds extending into the mouth must of necessity be sutured in order to preserve its shape and function, and here the surgical or harelip pin, with a figure-of-eight suture carried about it, gives the best results. The pin is carried half through the thickness of the lip, and can be removed in twenty-four hours.

In any bad wounds across the cheek, the facial nerve should be looked after, and if separated should be sutured at once in order to preserve the function of that side of the face. The subsequent care of such cases is the same as that followed in those of the scalp.

In the event of fracture of any of the facial bones, apposition of the fragments may best be accomplished by adjusting pads of gauze against the outstanding portions, or if there is very much distortion, the application of silver wire or silkworm-gut sutures, to hold the same in proper relation.

CHAPTER X.

FRACTURE OF THE SKULL.

CAUSES—DEGREES—SIGNS AND SYMPTOMS—DIAGNOSIS—PROGNOSIS—TREATMENT.

FRACTURE of the skull is frequently seen by the railway surgeon, on account of the prodigious forces which take part in the production of injuries. These fractures are as a rule very serious, from the fact that complications in the form of lesions to the brain are almost invariably associated with them, thereby presenting themselves as a class of injuries whose gravity causes great anxiety.

Fractures of the skull are divided into those of the vertex, and those of the base. By the vertex is meant all that portion included between the orbital ridges in front, the occipital protuberance behind, and the external auditory meatus on either side. The base of the skull includes all below and beneath these points.

Causes.

In considering the causes which produce fracture of the skull, leverage cannot be taken into any account whatever, for external violence, acting either directly or indirectly, is alone responsible for the condition.

Fracture of the vertex is made through direct violence, as when the head comes into actual contact with some

body. Those of the base are the result of indirect force transmitted to that region through the occipito-atloid articulation. Thus a blow on the head, or a fall on the feet or buttocks with sufficient force, may, by transmission through the vertebral column, expend its force at this point. In fracture of the base, direct force need not be considered, for the area of the region is beneath large, thick coverings, well protected from impingement.

It requires no small force to produce fracture of the skull, for the reason that its surface presents an ovoid, rounded box made up of several bones, whose articulations permit of some dissemination of force, which together with the natural elasticity of bone, here prominently in evidence, tends to a great degree toward diminishing the force of the blow. Again, the skull is covered by a dense, firm superstructure, which adds its cushioned surface to assist in modifying the effect of any force. The degree of elasticity of bone grows less from childhood to old age, and is accompanied by a corresponding decrease in the force of impact necessary to fracture the same.

The surface of the impinging body greatly influences the matter of a fracture being produced, for a narrow or sharp body will pierce the bone with a much less amount of force behind it than when the surface of the impinging body is flat and smooth. The line of fracture usually follows the line of force, and marks to some extent the form of the impinging body. The presence of the sutures of the skull at the point of fracture does not seem to influence the line of the same, and more frequently the latter crosses the suture than follows it all along its course.

On the railway, fracture of this region is usually caused

by a blow from some of the projecting parts of a locomotive or car, or from falling or being thrown from a train and striking upon the head. The degree of severity, of course, follows closely the degree of force. There is always present the complication, or the associated condition, of an external wound, for if the force be sufficient to fracture, it certainly is sufficient to cause a lesion of the soft parts.

Degrees.

As to the degrees of fracture of the skull, there may be many, from a simple fissure to the caving in of a large

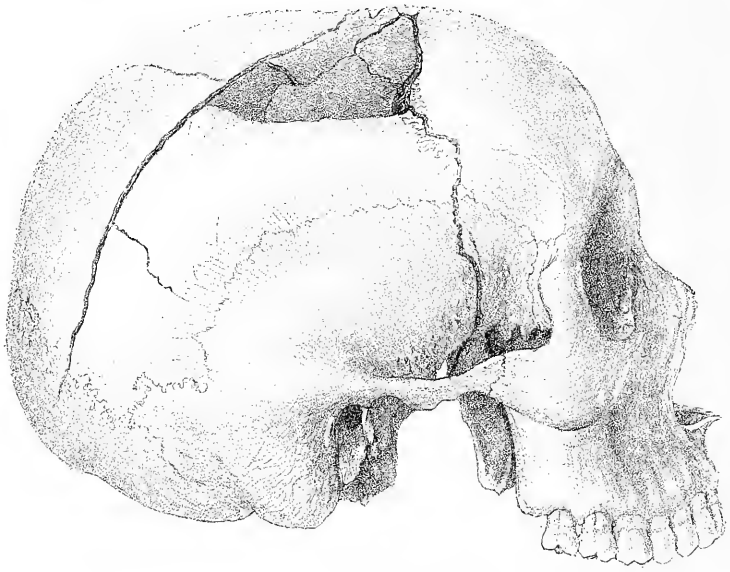

FIG. 36.—A Comminuted Depressed Fracture of the Vertex of the Skull, with several radiating fissures.

segment of the same. This also depends upon the force of the blow and the surface of the impinging body or bodies (Fig. 36).

At the vertex, the most common form is a depression of bone of small area, with one or two slight fissures leading from its opening. There may be a fissure or depression of the outer table alone, in cases in which the head

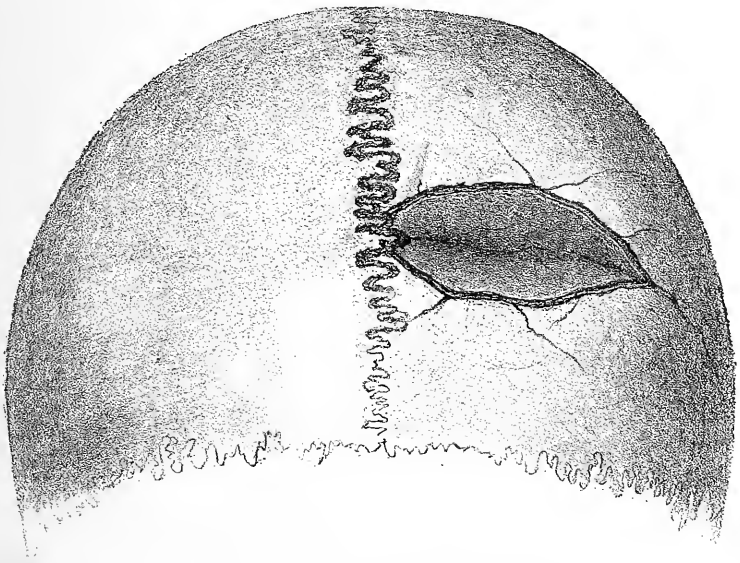

FIG. 37.—Fracture and Depression of only the Outer Table of the Skull.

has been struck a slanting blow which has glided off before its force could penetrate to the inner table (see Fig. 37). There may be a condition of fracture or splintering of the inner table without any sign of injury in the outer layer. This can occur only when the blow has depressed an unusually elastic skull just to the point of fissuring the inner table, which would here first occur. At this point the force recedes or diminishes, permitting the outer table to resume, through its elasticity, its normal contour.

Depressed fractures are never seen at the base, but usually a fissure runs from the anterior or posterior con-

dyloid fossa, irregularly up on the sides of the base of the skull (see Fig. 38).

All fractures of the vertex are associated with a lesion of the soft parts, and are frequently in a state of comminu-

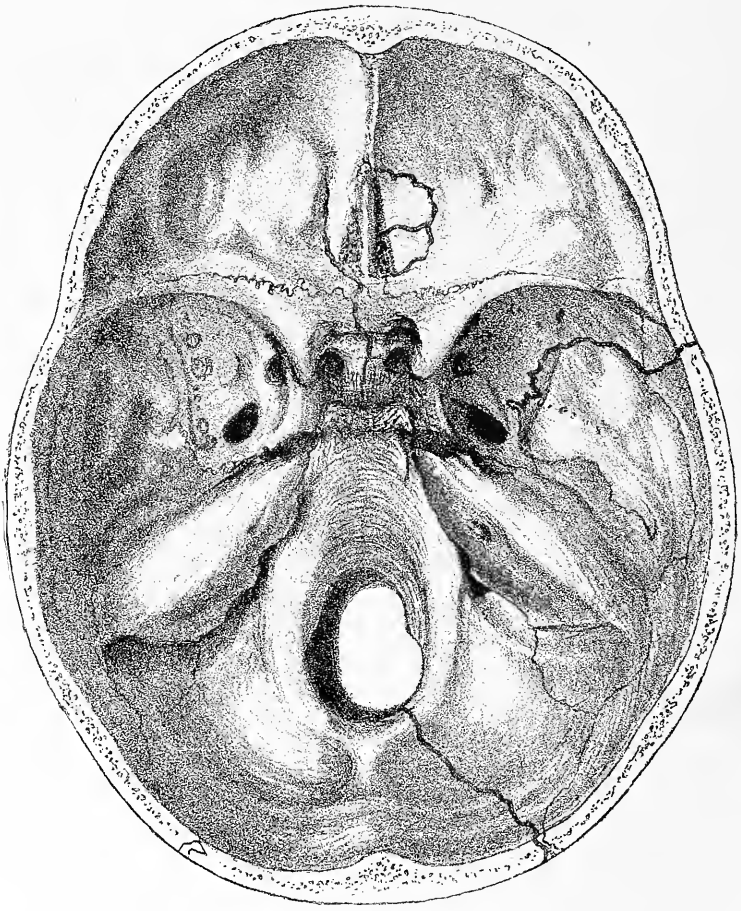

FIG. 38.—Fracture of the Base of the Skull, showing the radiating lines of the fissures.

tion. One edge of the fractured portion may yet retain its relation with the uninjured bone surface, while the other

end dips down into the brain substance, or extends under the edge of the surrounding bone; or the piece which is fractured may sink entirely below the level of the normal contour of the skull.

Signs and Symptoms.

The symptoms which these conditions give rise to are quite varied, and do not always seem to be just in accord with the injury. We have noted individuals who have walked great distances after having received a compound, comminuted, depressed fracture of the skull, and on the other hand have seen patients presenting the gravest train of symptoms, in whom no evidence of a lesion to the skull could be made out, and not found even on autopsy. Usually, however, the symptoms follow quite close along the lines the injury would indicate.

A freely bleeding wound, sufficiently open to disclose the broken surface of the skull, will usually present the opportunity directly to view the existing lesion, while an irregular and rather feeble pulse and respiration, with unconsciousness, will indicate to some degree the damage to the deeper structures. Shock is not usually an alarming condition, unless it be present as a direct result of the hemorrhage, which may be severe, especially if the lesion is near or over the meningeal arteries, the temporals, or the sinuses. Coma is usually present to a certain degree in every case, and should be given significance as indicating injury to the brain, according to the profoundness of the same. An inspection of the lesion will determine the severity of the case, that is, whether much damage has been produced.

Consciousness, on the other hand, does not prove the brain uninjured. If the patient is conscious, some pain is complained of, and vomiting is not unusual. If fissure only has occurred, without depression, the untoward symptoms abate and pass off, or if the external table alone is affected the same thing will occur. Absence of external bone lesion, with a continuance of any of the symptoms beyond vertigo and slight pain, may be considered as pointing to an injury to the inner table, or to the structures beneath it.

When fracture of the base is present, and in this we do not find depression, the stupor and apathy are very persistent, and although the individual can be aroused to consciousness, he sinks back again into coma.

Diagnosis.

As to diagnosis, it only becomes necessary to ascertain whether or not there exists an injury to the intracranial structures, for no fear need be entertained as to recovery from a fracture of the skull *per se*, inasmuch as there is in this condition no vital structure injured and therefore no alarm need be felt. The wound in the scalp permits of judgment being passed on the matter of fracture of the external table only, or of both tables. If the wound is large, the bone can be felt through it, and the area and extent of depression readily made out. If it is small it may with great propriety be enlarged so to give every opportunity for such examination.

In cases of simple fissure, the lesion will show itself as a red line, caused by the blood exuding from the diploe, and which cannot be washed away. The blood collecting in the

lines of a suture can be easily cleaned away, but that in the line of fissure cannot, therefore such a red line becomes positively diagnostic. A fissuring or fracture of the tables of the vertex, and also frequently of the base, will often be associated with a breaking through of the orbital plates of the frontal bones, and an exudation of blood in the upper eyelids, showing as an ecchymosis very early in the case. A simple fissure may not be followed by any bad symptoms whatever, and no extensive exploration is called for unless present or future conditions demand it.

FIG. 39.—The Puffy Appearance of the Scalp Resulting from a Blow, and so often mistaken for a depressed fracture.

A misleading feature which is apt to occur in blows upon the head, and be mistaken for a fracture, is the proneness of the pericranial structures to puff up around the site of the blow, presenting a raised edge with a depressed centre, very much resembling a fracture (see Fig. 39); but the absence of every sign of the latter is sufficient to clear up the diagnosis.

Convulsions are rarely seen at the outset, and when occurring later are diagnostic of spicula of bone, or other irritation to the dura mater or brain. Mental aberration is diagnostic of a laceration of the anterior convolutions of the cerebrum. Pupillary disturbance is not considered of value in a diagnostic sense, as variations of all kinds occur with similar and dissimilar conditions. There is

usually some fixity, and frequently irregularity of the pupils.

Stertorous and puffy respiration is usually present in great compression of the brain, but it is not at once relieved by raising the depressed bone. Temperature is a very valuable sign in noting the extent of laceration of the brain substance. Directly following an injury, the shock will cause the temperature to be lowered to a subnormal point, from which it ascends. If the case is a severe one, the temperature will make a rapid and high rise, thus indicating the certain mortality of the case.

When consciousness is present, a paralysis may be found, which in all cases points positively to a lesion of the brain at the point where such paralysis localizes, either that of a hemorrhage into the substance, or an actual laceration of the same.

Fracture of the base is accompanied by bleeding from the nose and ears, the latter being especially diagnostic if followed by a discharge of cerebro-spinal fluid. All other symptoms are frequently aggravated and the stupor is profound.

Prognosis.

The prognosis, in fracture of the skull, depends more upon the injuries which the intracranial organs have been subjected to than upon the lesion in the bone, inasmuch as the latter is in itself never fatal. When much destruction has been caused, death will occur at once, or very soon after the injury. The extent of the fracture, with the usual corresponding damage to the brain, does not prove the absolute prognosis, as very frequently fatality will

ensue after what seems to be a very minor fracture; while, again, recoveries have followed large, depressed fractures with considerable loss of brain matter.

The presence of the symptoms above noted, in their severest degree, points to a decidedly unfavorable prognosis, and the reverse is equally true. Cases which do not at first present, either externally or otherwise, any very serious outlook, may become dangerous at a later time; although the longer the time elapses since the receipt of an injury without the appearance of any of these untoward sypmtoms, the brighter the prospect. If the patient survives the first shock, becomes conscious, and continues to improve, the case assumes a much more favorable aspect. On the other hand, a continuance of stupor, and an increase in any of the symptoms indicated, mark the case as one of extreme gravity.

Fractures of the base may be said to be fatal, although this characteristic has changed somewhat during late years, and cases of complete recovery are becoming more numerous owing doubtless to antiseptics.

Advanced age is invariably a factor toward increasing the mortality rate in any case of fracture of the skull.

Treatment.

In the treatment of fracture of the skull at the base, little can be done. Rest, quiet, shaving the head, and the application of an ice-cap, and the washing out of the nasal and auditory cavities with an antiseptic solution, are the requirements. This latter procedure should be frequent and thorough, followed by packing of the cavities with an-

tiseptic wool. Nothing in the way of an operation or exploration is to be thought of or called for, inasmuch as there is no depressed bone to be restored to position or wound to be cared for.

In the vertex, the conditions must be met promptly. After administering stimulants to a necessary degree, proceed to wash the wound. Use plenty of water and a rather strong antiseptic solution, irrigating well, even into the substance of the brain if exposed, and following with sterilized water.

The hemorrhage from depressed fractures is usually quite severe, for we naturally have that from the external wound, and the large vessels beneath may be injured. In order to be able to work well, this must be checked at once, and either hæmostatic forceps used, or ligature applied. Very frequently the bleeding ceases after a few moments' compression with the forceps.

Clear out all foreign matter which may be forced deep into the brain substance itself, and use great care in getting rid of it all. If any bone is comminuted, remove the fragments, leaving any pieces which are yet attached to the periosteum, and have enough size or support to remain on the external contour of the skull. If any bone be depressed it must be raised at once. Usually it is possible to slip an elevator beneath one edge of the skull, and with firm pressure raise the piece to the normal level. If this is attended with much difficulty, and the segment seems to fill the opening completely, or will not stay in place when elevated, it will be necessary to chip off enough of its margins with the rongeur forceps to permit of its being fully and perfectly replaced. It is rarely necessary to use

a trephine in operating on depressed bone, as the nip of the rongeur will get an opening large enough, and without sacrificing more than is necessary.

If the dura is intact, let it alone, unless convinced that it is wounded, marking the possibility of a spiculum beneath. If it is injured, then, of course, make a free opening into the cavity, and search thoroughly for fragments of bone or foreign matter.

Always examine well around under the edges of the surrounding bone by a probe bent at right angles, to be sure there are no fragments left in. Do not suture the dura if once opened. If this is torn or ragged, carry a small drain or a few strands of catgut beneath it. In case of very severe hemorrhage from below, which cannot be controlled by forceps, it is safe to leave a packing of gauze for a few hours, to arrest this.

In dressing the wound carry gauze into the depth of any cavity beneath the bone, and from thence to the surface, apply a firm, bulky, absorbent dressing, covering all with a bandage and crinoline cap.

In case a fissure only is found in the skull, and no symptoms of injury to the brain are present, it is well to let it alone, biding the possible appearance of symptoms later on. When such exist, associated or not with a depression in the outer table, it is fair to presume that some damage has been done to the inner table, and therefore it will be far more satisfactory at that time to make a small opening through it and determine this point to a surety. This exploration cannot do harm if carefully done, while the condition of even a slight injury at this point may be far worse if left unattended. It is never safe to let a wound

heal altogether in such a case, without proving the situation by the above procedure.

When we come to the scalp wound associated with a fracture, we treat it as an open wound, removing all the hair by shaving, and applying a crinoline cap firmly over all. It is unnecessary to state that these cases should be redressed every day, and if any packing is left in the wound it should be gradually withdrawn as the cavity closes by granulations. If pus should form, the dioxide of hydrogen may be used to keep the wound clean.

FIG. 40.—Hernia Cerebri. (Case of the author's.)

The after-care of such cases is to watch carefully for symptoms marking further damage. Sepsis will make its presence known by a sudden rise in fever, with probable chills. Immediate exploration of the depths of the wound is then indicated, together with antiphlogistics and supporting treatment. Paralysis or twitchings also mark the condition of deeper and positive damage to the brain, requiring a reopening of the wound to discover the offending particle.

The bladder and bowels are always to be carefully looked after, as to relief and antisepsis.

As a subsequent condition following fracture of the skull, when there is an external opening left, may be men-

tioned that of hernia cerebri, or a protusion of peculiar formation through the opening (see Fig. 40). The appearance of this is similar to wound granulations, red and bleeding, but in no particular resembling brain matter. There is no seriousness whatever in the condition, and the treatment consists in paring off the excess, applying mild astringents and firm pressure, under which treatment it gradually disappears.

As to the opening in the skull, if small, it may be left alone, as a fibrous membrane will usually form across it from the periosteum, with enough rigidity to protect the brain. Never try to put back pieces of bone, or trephined buttons which have been completely severed. They will not affix themselves, but will become carious, and thus necessitate subsequent removal. When the space is large, and doubts are entertained as to its being closed to a degree sufficient to warrant the brain safe from injury, covering the opening with artificial plates may be thought of. Gold, platinum, or silver may be considered, in value from the first named. Otherwise, the scalp may be made to cover the opening by a sliding operation, leaving both ends of such a flap attached, the bridge thus made to cover the opening. The dissection of this flap should not include the periosteum, for this would lead to caries in the bone so uncovered. The space left by the transplanted tissue will fill in by granulation.

Caution should be exercised in giving consent to a patient recovering from a fracture of the skull to return to work, especially if the occupation is laborious, or involves stooping, or the weather is hot. Some weeks or months usually elapse before the mental faculties are fully re-

stored, while any subsequent symptom referable to the head as a cause therefor, should at once be coupled with the history of the previous fracture and treated accordingly. Of course in slight cases, and in those in which the symptoms are modified or in no wise serious, no such extreme caution need be observed, and such individual may go about his usual avocation as soon as the general symptoms in the case warrant.

CHAPTER XI.

FRACTURE OF THE VERTEBRÆ, RIBS, PELVIS, LOWER JAW, AND CLAVICLE.

Fracture of the Vertebræ.

Causes.

While fracture of the vertebræ is not particularly common on the railway, yet direct violence of a blow on the back, or falling across some projection, may cause it. It is impossible for any twist, jar, or shake-up of the body to have sufficient force to fracture any of the vertebræ or their processes. Considering the anatomical make-up of the spinal column, its numerous and well-padded vertebræ, its elasticity, its protection by huge bulks of muscle, it is easy to be seen that nothing less than a crushing force given externally upon it or a violent flexion of the back could dislodge a fragment from the spine or separate the bone at the transverse processes.

Signs and Symptoms.

The signs and symptoms of such a lesion indicate at once the severity of the condition. Some pain from the injury, increased upon motion, tenderness, irregularity in the line of the spinous processes, and possible detection of loose fragments, especially if the subject is thin, point to the location of the fracture, while immediate paralysis

in the lower extremities (which is a complication to be feared) points to damage to the cord.

A blow upon the back would, of course, be severe in its effects upon the system generally for a period, and at the time of receiving it the individual might be wholly unable to help himself, yet it will become an easy matter to differentiate between this condition and true paralysis.

The diagnosis then may be clearly made, and while the unmistakable presence of a fracture of the bone may be made out, the seriousness of the case would depend entirely upon the complication above stated.

Prognosis.

Seldom are these injuries serious, so far as the bone or coexisting lesion of the soft parts is concerned; but the complications caused by the violence, or the impinging of the fractured fragments on the spinal cord, are the dangers to be feared. The absence of any cord lesion gives a favorable prognosis to the case at once. Shock is not present to any great degree, as a rule. It must be remembered, however, that on account of the rigidity and strength of the spinal column, any force delivered against it in sufficient degree to produce a fracture is capable of producing other lesions, either of internal organs or other structures, and therefore the possibility of such being present should always be borne in mind, to the end that the prognosis may be guarded. The presence of shock should, of course, excite suspicions of other complications.

Treatment.

The treatment of fracture of the vertebræ should be along the lines of necessity. Rest in the recumbent position is all important. Shock should be combated in the usual way, and the appearance of symptoms pointing to other lesions met as their nature indicates. When all signs point to fracture, with or without a lesion of the cord, the operation of laminectomy should be performed at once, or within a few hours, to relieve any possible pressure of the fragments.

When a favorable issue succeeds, all the symptoms abate very soon, gradually but positively disappearing. The application of a plaster jacket or corset is indicated in all cases of fracture, and especially after the operation of laminectomy. The jacket should be kept on for a period of from four to six weeks, when all symptoms should have vanished.

Laminectomy.

To perform this operation the patient should be laid, back uppermost, on a hard table, with the abdomen supported by a firm pillow. After anæsthetizing the patient and rendering the skin scrupulously aseptic over and around the area in which the injured vertebræ are located, a bold incision is made through the soft parts down to the spinous processes (see Fig. 41). Hemorrhage need not be feared, as it amounts to but little and is easily controlled by pressure. Retracting the margins of the incision, blunt dissectors may be employed to separate the tissues and freely expose the vertebræ. If any loose fragments are found,

they should be carefully taken away, and sharp points removed with the rongeur forceps. If the removal of loose pieces of bone opens the way for an examination of the spinal cord and canal, this may be done by passing a bent probe upward and downward within the canal. If any obstruction is then found, it should be exposed and relieved.

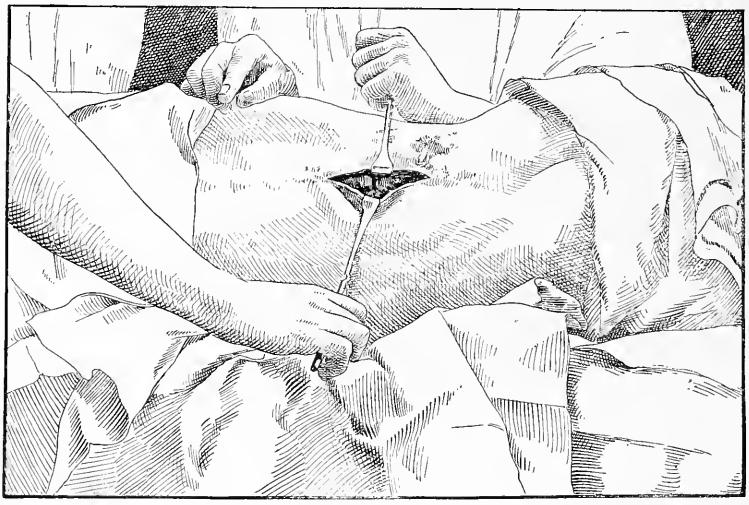

FIG. 41.—Position of Incision for the Operation of Laminectomy (when the injury is in the dorsal region).

In doing this the rongeur forceps should be employed, and by biting off the lamina of the vertebræ piece by piece, no more is removed than necessary.

If the dura is intact, it should be left so, unless there is evidence of bulging of its walls. In this case an incision should relieve its distention.

Before leaving the field it is well to remove the pillow upon which the abdomen has been resting, and note whether there is any change in the relations of the ver-

tebræ or fragments which might be disastrous to the structures of the cord.

The external incision should be closed with silkworm gut, using deeply placed sutures in order thoroughly to close the depths of the wound. Drainage is unnecessary, unless it be found that hemorrhage comes from within the spinal canal, in which case it would be better to insert a small drain to facilitate its discharge.

Fracture of the Ribs.

Fracture of the ribs is rather frequent on the railway, as it is caused by jams, blows, and falls. The force is direct, and applied either laterally or anteropo-steriorly. It is usually a simple fracture, unless the fragment forces its way into the tissues beneath or into the skin without.

Force applied laterally drives the fragments inward, while antero-posterior force bends them outward. The condition is a frequent complication of other injuries.

Symptoms.

The results of a simple fracture are local pain, short respirations, and, at times, crepitus. When the fractured ends point outward they can frequently be felt under the skin. The individual locates the position of the lesion, as there are usually but few external markings. There is no shock or hemorrhage, unless the internal organs are injured.

Uncomplicated, the fracture is not serious, but frequently we find that the jagged end of the fractured rib has penetrated the structures beneath, and there is, as a

result, emphysema, hæmoptysis, a subsequent localized pneumonia, or pleurisy. These complications are accompanied by corresponding symptoms. Some hæmoptysis usually denotes the condition of puncture of the lung.

At times, with fracture of the lower ribs, a puncture into or through the diaphragm has been noted, and an injury to the liver produced.

A condition frequently observed in cases of puncture of the lung is an emphysema of the cellular tissue, causing some irregular swelling about the seat of the puncture, and giving to the palpating finger a peculiar crackling feeling, this being pathognomonic of puncture of the lung, and requiring no special attention.

When any of the above-described complications are present, the shock produced is greater, and the individual may be unconscious. As in all injuries, this condition of severe shock should always call for close scrutiny to discover its cause.

Treatment.

The treatment of cases of simple fracture of the rib is rest to the part by a complete envelope of bandage or adhesive plaster around the chest, applied as firmly as possible. In this way the ribs are forced to quietude, the breathing becoming abdominal. A plaster-of-Paris dressing is also to be recommended when no external wound is present, and when the patient is not likely to be well cared for, in order to keep the dressing closely in position. Anodynes are seldom necessary, as the application of a proper dressing, as above noted, gives almost absolute relief from pain.

If an external wound is present it should be disinfected to its depth, all foreign matter being removed, and drainage instituted, a firm absorbent dressing covering all. All complicating conditions referable to the pulmonary structures should be treated upon lines appropriate to each condition as it appears.

When a fracture of the ribs accompanied by a puncture of the lung occurs in elderly people, it is wise not to keep them on their back for too long a period for fear of a hypostasis of blood which may supervene in the lungs. Get such patients out of bed, or in a sitting posture, as soon and as often as is compatible with the condition.

Three or four weeks is usually a sufficient length of time for a dressing to be kept upon a fracture of the ribs, and the absence of pain in breathing may be the guide to the permanent removal of all dressings so far as the bone is concerned.

When an external wound is present, perfect cleanliness and a gradual withdrawal of the packing, as the wound fills up, until it is healed to the surface, meet all the indications.

Fracture of the Pelvis.

Fracture of the pelvis is not uncommonly met with in the practice of railway surgery, as it may be caused by falls, and particularly by crushes between cars. It is a condition which is apt to be serious, for it is almost certain to be complicated with injury to the bladder or genito-urinary system, which lie within the confines of the pelvis.

Symptoms

Pain, inability to walk, possibly crepitus, and hæmaturia are the usual train of symptoms present. External marks are liable to be found, as by reason of the great force necessary to inflict this damage, the soft parts rarely escape entirely.

In the absence of additional complications shock is not present to any marked degree. As before stated, we may generally expect to find further injuries. In that case the shock is proportional to the extent of injury present.

Hemorrhage when abundant in the urine may be looked upon at once as diagnostic of the condition of rupture of the bladder. If such a condition is suspected, immediate examination of the bladder is very important; and inquiry as to when the patient last voided urine, with an estimation of the quantity retained, and the color will, lead to a conception of the injury. The mere presence of hæmaturia is not pathognomonic of rupture, as it accompanies all fractures of the pelvis, owing to the bladder walls being strained or congested without actual rupture taking place.

Treatment.

As the line of fracture frequently extends into the acetabulum, some fear may be felt for the motion in the hip-joint subsequent to the repair of the break. As to treatment, absolute rest in the recumbent position, with the thighs semiflexed to relieve the strain upon the psoas muscles, and fixation in that position by a permanent dressing of plaster-of-Paris, are all that is required, be-

sides looking after such complicating conditions as may occur. If an external wound is present, firm bandaging with muslin and crinoline should be used instead of plaster-of-Paris.

After from four to six weeks crutches may be advised and the patient allowed to walk around. Early passive motion of the hip is desirable to ensure perfect motion in that joint.

Prognosis.

Prognosis in these cases should be guarded on account of the possibility that the complications may turn the case into unfavorable channels. If the genito-urinary tract is uninjured, no fear need be entertained as to the final outcome of the case. As in all fractures of the lower extremity, confinement to bed for so long a period, with the resulting debility therefrom, is very apt to give rise to neurasthenic conditions in individuals of a nervous type, and this should be anticipated and guarded against by a frequent change of the position of the bed and room, and by getting the patient up and into the outside air as soon as possible.

Fracture of the Inferior Maxilla.

Fracture of the lower jaw may occur as a result of being violently thrown from a moving train and alighting on the face.

Not being protected by clothing, the parts are usually severely bruised as a consequence of the fall; and directly afterward the patient complains of an inability to move the jaw without suffering pain and sometimes a grating feel-

ing as well. Frequently one or more of the teeth in the neighborhood of the fracture are loosened or completely knocked out.

Diagnosis.

The diagnosis is readily made out by manipulation, disclosing a point of separation in the bone, frequently at or near the symphysis. The line is usually oblique, and frequently gives a well-marked sense of crepitation.

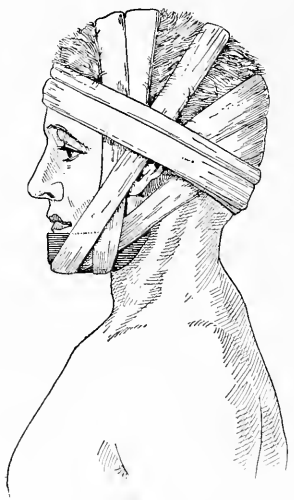

FIG. 42.—Dressing for Fracture of the Inferior Maxilla.

At times several fractures are present, at little distances apart, or a compound fracture may have resulted from excessive violence.

Treatment.

The treatment of such a fracture depends upon the completeness of the separation of the fragments. If the lesion is but a "crack" with little or no displacement, the bone being well held by the soft parts, a simple moulded appliance of felt, fitted to the conformation of the jaw and completely enveloping it from symphysis to ramus, will be found satisfactory (see Fig. 42).

In case the fracture is complete, and especially when it is located well back from the symphysis on either side, where muscular action draws the posterior fragment upward, there is usually great difficulty in keeping the parts in their normal relation. In such cases it will be found that nothing short of an incision, and apposing the frag-

ments firmly together with silver wire, will accomplish anything like a satisfactory result. Such an operation should be followed up by a dressing of moulded splints as above noted.

In case the condition is one with a complicating wound in the soft parts, the latter should be well cleansed and drained, and if it communicates with the cavity of the mouth, much difficulty will be found in restraining the saliva and keeping the cavity of the wound clean. Washing out with dioxide of hydrogen will greatly assist in this matter.

Prognosis.

The progress of cases of fracture usually continues favorable to a good result within from four to six weeks, although as soon as the feeling of rigidity is imparted, some passive motion can be daily made, the splint being otherwise retained.

It is unnecessary to remark that solid foods are interdicted, and that in some cases the removal of a tooth becomes necessary in order to introduce fluid food.

In case wiring has been done, it sometimes happens that the wire separates, or the fragments become loose through a necrosis around the drill holes, when the necessity arises of repeating the operation or otherwise holding the parts in apposition. If the teeth on each side be solid, great assistance can be obtained by wiring these together.

Fracture of the Clavicle.

Fracture of the clavicle is rather a common condition, as it is easily produced by falls upon the shoulder, the

bone being most frequently fractured near its middle, rather inclining toward its outer end.

The line of fracture is in nearly all instances oblique, the inner fragment being drawn upward by the sterno-cleido-mastoid muscle, thus making a marked prominence, ordinarily easily observed at a glance, or by slight palpation.

Diagnosis.

The diagnosis is made upon the following points: of a fall; drooping of the shoulder; pain in the part, increased by motion of the arm of that side; detection of the irregularity in the line of the bone; and, at times, crepitus.

Treatment.

As to treatment, the indications are to give absolute rest to the arm of the injured side, and to retain the fragments in as normal a relation as possible. Absolute normality is never attained, but by means of certain dressings fair apposition is ordinarily secured. As every effort in this direction must be made indirectly, by reason of the protected position of the bone, perfect apposition of the fragments cannot be effected.

Of all the dressings recommended for this condition, none has given the author more satisfaction than the bandage as described below. As it is easily applied and worn, and gives perfect rest to the arm of that side, it accomplishes as much as any dressing can, and it is free from the disadvantages of the irritating plaster straps, and from the difficulty of readjustment when change of the dressing is necessary.

To apply the dressing, place a pad over the fracture, the corresponding arm being thrown across the chest. Begin toward the fractured side and pass a turn or two of a large, wide roller completely around the chest, including the arm of the injured side. Then carry the turn to and over the affected shoulder, down along the

FIG. 43.—Dressing for Fracture of Clavicle, front view; bandage running from left to right.

line of the upper arm and under the flexed elbow of the same, up again over the affected shoulder in front, then down across the chest behind to the starting-point at the side of the chest of the opposite side (see Figs. 43 and 44). The turns should then alternate completely around the chest, including the arm of the affected side, and over the shoulder and elbow as above until several have passed over each, and a firm dressing has been made. Over all this ap-

ply a crinoline, or, if desired, a thin plaster-of-Paris bandage, sufficient to hold the dressing firmly in position.

This dressing constitutes a complete covering, and the action of the bandage, as will be readily made out in its application, is to carry the affected shoulder up-

FIG. 44.—Back View of Fig. 43, carrying bandage over fracture and under the elbow of same side.

ward, outward, and backward, in order to get as much extension in the line of the clavicle as possible.

The length of time such a dressing should remain will be from four to six weeks, although the bandage should be replaced as often as it shows signs of loosening. The ease with which this can be done precludes the possibility of harming the relation of the fragments in the least.

When after a time movements can be made in the arm without any pain in the part, the dressing may be removed and motion given freedom.

It is very seldom that any permanent effect is noticed in the motion of the arm after such a fracture. The callus is usually considerable in size, owing to the displaced fragments, but rarely interferes in any way with the comfort of the individual.

CHAPTER XII.

FRACTURE OF THE EXTREMITIES.

In considering the subject of fractures, we wish to be understood as not including cases of crushing, or those in which the extremity has been run over by a train, but only those of fracture of various degrees occurring through direct violence or leverage.

There are particular points regarding these cases that bring them prominently before the surgeon, and while some of these are to be noted in fractures produced by other causes as well as by the railway, yet altogether they are so frequent as to be worthy of special study.

Varieties.

As to varieties, all are seen, though in marked disproportion. Simple fracture, or a single break, uncomplicated by any other lesion near or remote, is less often met with on the railway than are others.

The condition known as impacted fracture is not met with in railway service, for the reason that leverage alone never leaves the bones in a forced end-to-end apposition, the definition of impaction. While falls do occur, the individual is invariably rolled over and about to a sufficient degree to break up such a cohesion, even if it did occur at the first moment of impact.

For the same reason multiple fractures, or those occurring in more than one place in the same bone, rarely take place without one or other of them resulting in a compound fracture, due to the continuance of the force which has been severe enough to cause more than one break.

Compound fractures, or those associated with a wound of the soft parts directly in line with the bone lesion, permitting the ends of the bones to protrude, are the ones most frequently met with, and almost in every case these fractures are in a state of comminution, the bone being broken into two or more fragments just at the point of injury. These are the worst forms to deal with, because all wounds happening on the railway are septic from the first, and owing to the violence that produces the injury, the soft parts are so torn and twisted, the ends of the bone tearing the muscle, that sepsis finds its way more easily into the wound to such an extent as to very materially affect the final prognosis of the case. Hence it is evident that special consideration and care have to be exercised in order to overcome these influences.

Again, the force causing a compound comminuted fracture of a strong bone is frequently expended on other parts of the body at the same time, and remote lesions, either apparent or obscure, are very apt to be influential factors in directing the case into unfavorable channels.

Diagnosis.

The diagnosis of fracture is comparatively easy. The patient being conscious in the majority of cases, he is able to point out the site of his injury. If the fracture is simple, the ordinary signs of it will be present. Inabil-

ity to use the extremity, pain, increased mobility in handling, crepitus, and some deformity depending on the location of the break, are the points to determine. None of these signs is independently pathognomonic, but must be

FIG. 45.—Fracture of both Bones of the Forearm, showing the marked deformity.

coupled with others with sufficient certainty to establish the diagnosis.

Many times, and it may be said usually, a fracture needs but a glance or a touch to be recognized (see Fig. 45), although in some forms of impacted fractures, or in case the individual is fleshy, some obscurity is often present.

Inability to use the part, in complete fracture, is caused by the loss of the natural support, and the pain upon at-

tempts to move it. Crepitus is not always distinctly made out, while a sensation similar to this is at times produced by tendons or cartilages rubbing against one another. The deformity must be weighed with other signs when in the proximity of a joint, in order not to be confounded with a dislocation. When an irregularity of outline presents away from a joint, or in the shaft of a bone, it is especially significant of fracture. If fracture occurs close to a joint, the ligamentous structures of the joint may hold the fragments so closely in their normal relations as to mask the fact of fracture. In these cases pain will be present, which, with immobility, coupled with the history of a fall or violence suffered by the part, will be sufficient for a presumptive diagnosis of fracture until subsequent observations make it clear.

In compound fractures, whether the individual is concasious or not, the diagnosis does not require more than glance at the injured parts (see Fig. 46). Nothing is needed but an examination into the details of the case to determine its severity. This usually requires the administration of an anæsthetic in order to be accomplished thoroughly, and while the patient is in this state the dressing can be attended to. In these cases the surgeon should not rest content with the idea that it is the only injury present, but should observe the general condition of the patient, and determine, by rapid but close scrutiny, the possibility of other lesions quite as bad as, or maybe worse than, the fracture.

Associated conditions that always accompany a compound fracture are hemorrhage and shock. The former, of course, is caused by, and begins with, the tearing of

the tissues, and it may be that a large vessel is implicated, making this a very serious matter and one which endangers the life of the individual. It is a condition, too, that may be deceptive in its extent, for while the external opening in the skin may be plugged by bone or protruding

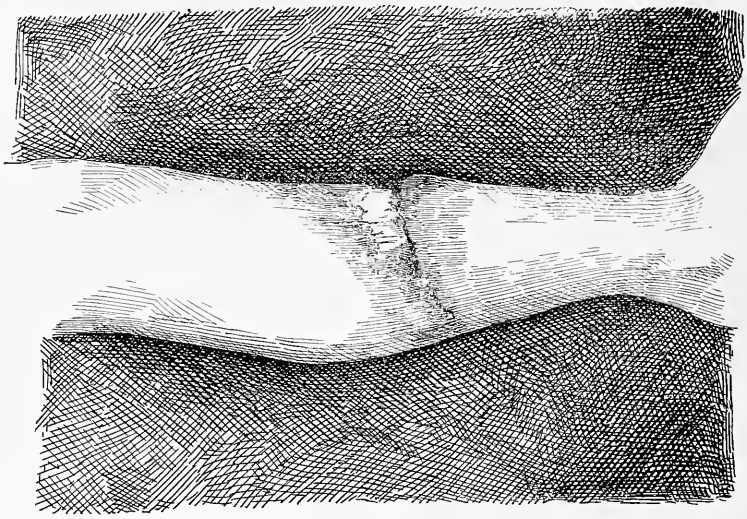

FIG. 46.—Appearance of a Severe Compound Fracture.

muscle, hemorrhage may continue within, and, burrowing its way between the tissues, accumulate to a degree sufficient almost to exsanguinate the individual before it even shows as oozing on the outside. In fact, this condition may ensue as a result of a simple fracture, as was noted in a case coming under the author's observation.

In this case a simple fracture of the tibia, close to the head of the bone, was sustained through direct violence from above. Having been diagnosed and treated as an ordinary case, it was noted a few weeks later that not only was there mobility in the fragments, but on the

outer side of the site of the fracture a swelling of some prominence appeared, which was thought at first to be excessive callus or displaced fragments. When the case was seen at this time, the swelling was found tense but soft, and, by exploration, discovered to be blood clot. This being cleared out through a free incision, it was found to occupy nearly all of the interior of the calf, except the bone, even finding its way down between the muscles which had almost entirely disappeared. When the bottom of the cavity was reached, fresh blood appeared, followed by a sudden gush from the popliteal artery itself, which was discovered to have been entirely severed by the edge of the upper fragment at the time the injury was received. The consequent hemorrhage had been checked by the resistance of the remaining tissues of the part, which through pressure were gradually wasting away. Amputation was the outcome of the case.

Shock is usually present in severe cases, its degree depending upon the severity of the mangling of the tissues and the amount of the hemorrhage. The appearance of this condition of shock, in less severe cases, may be the possible manifestation of serious complicating injuries.

In the case illustrated in Fig. 12, in which a compound fracture ensued in the right leg by being directly run over by car wheels, and the left leg was completely devitalized although the skin remained unbroken, shock was so severe as entirely to preclude any operative measure for the relief of the injury, which finally resulted in death.

Treatment.

The temporary treatment of fractures, to be given on the spot where the case is found, should be that of meeting all the necessities present, and of checking the possible unfavorable contingencies of the two or three hours following.

After the condition of shock, if present, has been attending to, a simple fracture should be placed in splints, or the extremity should be bound to its fellow or to the side of the body, so as to secure immobility of the part until the permanent dressing can be proceeded with.

In compound fractures the injury should be given every attention that is required in open wounds, such as a thorough washing and packing, and a checking of the hemorrhage, for it must be remembered that to be painstaking in these primary attentions and dressing means much toward the future welfare of the case. After the parts are immobilized as securely as possible by splints or other means, as above stated, the individual may be transported, unless his physical condition, the severity of the fracture, or coexisting lesions prohibit it under the rules laid down in previous chapters on the subject of transportation.

The permanent treatment of fractures is one that must be carried out on the lines directed by the location and severity of the case, the general condition of the patient, and the occupation and civil relations held by him.

In simple fractures of any locality without lesion of the soft parts, the bone should be placed in perfect line and position, and held there by means of a dressing sufficiently rigid to take the place of the broken bone in keeping the

parts in their proper relation, until the bony union has perfected itself. The limb being held fully extended in the normal line of the bone, a splint should be applied in close contact with the skin, and secured by bandages and crinoline, making an admirable support, one easily applied, and as easily removed and inspected. No dressing that gives rise to continual pain should be allowed to remain. The freedom from pain is an indication that the proper relation of the parts has been attained. Plaster-of-Paris in any form should not be employed, for the reason that parts thus covered up are hidden from inspection, so that the surgeon cannot keep in touch with the condition of the fragments and their relations.

From four to six weeks ought to be sufficient time for simple breaks to repair themselves. Passive motion should be made before this time to some extent, especially if the fracture is near to or in a joint. Here the new bone will interfere with free motion, unless moulded into proper relation by frequent movement of the joint during the repair of the break.

Treatment of Compound Fractures.

It is in compound fractures that the anxiety comes, and as these are the ones most frequently met with by the railway surgeon, they should be given greater and closer attention. The rules given for the treatment of wounds should apply here as to the primary scrubbing, shaving, and removal of foreign matter from the wound. If the hemorrhage is severe it must be controlled, either by pressure or ligature. In the latter necessity the wound must be opened or enlarged to a sufficient degree to permit of

securing the vessel. Ordinarily the pressure of the dressing will be found sufficient to check the bleeding. When the end of a bone protrudes and cannot be replaced in its proper position even through an enlarged incision, enough of it should be sawn off to allow this to be done, during which procedure great care should be taken that no soft structures are imprisoned between the ends of the bones. A thorough disinfection of the cavity is imperative, and subsequently a thick gauze drain should be carried down to the bottom of the wound. Neglect of this precaution permits fluids to form pockets in the tissues and become septic, as may be denoted later by fever, chills, pain, and swelling in the parts.

If the bone is comminuted, and small detached pieces lie loose, they should be removed. If any large segments are found still attached to the periosteum, they should be left *in situ*, and if it is impossible to retain pieces so large that their removal would greatly diminish the length of the extremity, they may be held in place by suitable wiring.

After all these details have been attended to, in which operation an anæsthetic will be found necessary, the parts should be included in a firm, bulky, absorbent dressing, over which splints should always be applied, and the joints above and below the fracture should be included in the dressing, in order to keep the parts at perfect rest.

In compound fractures of the thigh, the foot of the bed should not be raised, as is ordinarily advised, because gravity is likely to assist discharges from the wound in pocketing or burrowing high up on the thigh. In lieu of this elevation, counter-extension can be secured by

fixation of the shoulders, or by a well-padded perineal band.

The use of plaster-of-Paris dressings in compound fracture is strongly condemned. It precludes the possibility of inspection of tissues and parts whose vitality is yet an open question. Even with fenestræ it is impossible thoroughly to examine the condition of the fragments, or to prevent discharges from getting underneath the dressing and form hotbeds for infection, with abrasive inflammation of the surrounding skin, even followed by sloughs. These are cases above all others in which one must keep in touch with the exact condition, in order promptly to meet all possible complications.

Any neglect in the temporary treatment of compound fractures means the probability of permanent mischief. A patient should never be allowed to pass out of one's hands to be transported, even for a short distance, without having received all the attention the case demands.

Prognosis.

The prognosis in cases of fracture can be summed up as follows: In simple lesions affecting the middle of the shaft it will be good, as regards both function and life. In joints, the restoration of function will depend on the severity of the fracture and the amount of care bestowed on passive motion.

In compound or comminuted fractures, function is rarely perfectly restored. The deposit of new bone and of new tissue is always conglomerate, and never can replace, fibre for fibre, the various anatomical structures that

have suffered destruction. Therefore a certain amount of limited motion will unavoidably ensue.

The prognosis as to life in these cases will depend upon the severity of the injury, and the complications of shock, hemorrhage, and sepsis, any one of which is capable of ending fatally, independent of the bone lesion, and until these dangers are passed we cannot make any prognosis with safety or surety.

Conservatism.

As to the preservation of the extremity, the severity of the injury and the complications, in conjunction with the question of conservatism, will decide. The latter is an important matter, especially when the lower extremity is involved.

Can we, or shall we try to, save the extremity when a doubt exists? The injury itself may decide the fact when the jagged ends of the bone have severed the main trunk supplying the extremity. Such cases are frequently met with, and have almost invariably shown that in the general devitalization of the parts by the injury, collateral circulation cannot be depended upon to occur in time to save the life of the part, and amputation has been the unavoidable outcome of many attempts in this direction.

A case in point was that of a fracture of the upper end of the ulna, making but a buttonhole wound in the skin, but severing the brachial artery. On account of the comparatively slight lesion of both bone and soft parts, treatment was conservative. Sloughing of the muscles of the forearm shortly occurred, and before collateral circulation was at all established the arm was useless from loss of muscle.

Because of this, and of the accompanying pain in the part, amputation was willingly submitted to, eighteen months afterward.

In a similar case of impingement between dead woods of freight cars in which no damage at all was done the bones, the circulation was so completely cut off as to be followed by gangrene of the forearm within three days. There was no wound whatever in the skin, simply a bruise.

When the artery is intact, but comminution of the fragments or the involvement of a joint is part of the lesion, the question of resection may be considered, and preference given it over amputation. When much injury is done the soft parts, resection would be valueless.

The general condition of the individual has much to do with the outcome in compound fractures. The author has seen cases of simple fractures become compound through the sloughing of the tissues at the point of break in the bone, with the subsequent formation of abscesses and septic infiltration of the surrounding tissue, so that amputation of the extremity was performed in the hope of bettering the condition, but it finally ended in collapse and death. This shows that it is not safe to predict a certain result in any case of fracture.

Again, the vocation of the individual should be taken into account. We could recite many examples of compound fracture, with considerable coexisting lesion to the soft parts, in which amputation was set aside for the question of conservatism. Months and years elapsed before the men were restored to a working condition. Some never did get out of the crippled state, and a few

submitted willingly to amputation, to rid themselves of a useless appendage.

Now when such injuries in a laboring man come before us, the question as to how much a leg is worth is a serious one. It is often difficult to decide whether it is better to keep a man for an indefinite period from his labor, and the benefits of it accruing to his needy family, or whether it is better to do a radical operation at once, and send him back to his work in a few weeks at most. In these days of perfected prothetic appliances, the patient is not handicapped so much as victims of amputation formerly were, hence conservatism must include the latter question.

Of course all this relates only to those cases in which a great deal of doubt exists as to the final outcome of the life of the part and as to its function.

After-Care of Fractures.

As to the after-care of fractures, whether simple or compound, they should be frequently inspected, and cleansed in the same thorough manner as at the first instance. The bone should of course be kept in perfect line. No dressing that gives pain should be allowed to remain in place. In compound fractures, it should be remembered that the soft parts must heal to a considerable degree before the bony union will begin. Some shortening is bound to occur in this class, as also in simple fractures of the long bones.

The ecchymosis, which usually surrounds the field in every case, gradually fades through the varying shades of green and yellow, and finally disappears altogether. Some atrophy of the muscles may also occur.

Passive motion should be given the parts as soon as a feeling of rigidity is imparted on examination. The patient should always be informed that some shortening and deformity are pretty certain to result, lest he may censure the surgeon later for careless treatment of the case.

When the rigidity gives place to the normal condition, the supports should be discarded, and in fractures of the lower extremities the use of crutches enjoined for a week or two.

Non-Union.

If after twelve weeks no attempt on nature's part has been made to reunite the broken bone, and the soft parts have firmly healed over, we have a case of pseudo-arthrosis, or non-union, to deal with. The causes of this may be local or constitutional. Fibres of tissue or muscular bands interposed between the ends of the fragments may be the fault.

To secure union, any one or more of several procedures may be adopted. The administration of tonics and lime salts internally, and the rubbing together of the ends of the bone may accomplish results. Plaster-of-Paris dressing in a shape of a mould permitting the individual to walk about carefully will frequently succeed. Otherwise an incision may be made and the fragments wired together in proper position. This is not, however, always successful, for there may still be present the constitutional condition to thwart us. When the fracture is near a joint, and the long disuse has brought about a condition of partial ankylosis in the articulation, a new difficulty is encountered. Here, attempts at forced motion loosen the fragments still more.

In a case of the author's, similarly affected by a non-union of a fracture in the femur close to the knee, the patient went about using the ununited fracture as a false joint, the natural one becoming fixed, the final result giving him a very satisfactory leg.

Lateral supports have to be applied in cases of this kind, and in the event of failure to secure union, a permanent fixture of a prothetic apparatus may have to be the outcome.

CHAPTER XIII.

CONSIDERATION OF SPECIAL FRACTURES: FRACTURE OF THE HUMERUS, ELBOW, RADIUS, AND ULNA — "COLLES' FRACTURE" — FRACTURE OF THE FEMUR, PATELLA, TIBIA — "POTT'S FRACTURE."

THE foregoing chapter notes the important points to be observed in the diagnosis and treatment of fractures of the long bones, and indicates, in a general way, their prominent features. There are some fractures that are more frequently met with than others in railway service, and to the consideration of these, additional pages are devoted.

FRACTURE OF THE HUMERUS.

The humerus may be fractured in its shaft or at either extremity. Fractures of the shaft are easily recognized, and have no points in particular. When the injury occurs at the upper extremity, there is a close resemblance to dislocation of the head, and many times the differentiation is difficult. Aside from the ordinary signs of fracture, such as crepitus, deformity, pain, and inability to move the arm, it will be found that in uncomplicated fracture the elbow of that side can be easily carried close to the side of the chest. If a dislocation is present, this cannot be effected. Rotation of the shaft without a corresponding

movement of the greater tuberosity also points to the presence of fracture.

Treatment.

In treating fractures thus located, the necessary points are effectual restoration of the fragments by extension, and perfect subsequent rest to the entire arm. Thin splints applied directly to the arm, with but slight padding, and firmly bandaged, will usually obtain coaptation in the

FIG. 47.—Dressing for Fracture of the Humerus.

bone; while padding the arm-pit, and bandaging the entire arm, including the immediate dressing, to the chest will give every opportunity to retain the parts in their normal relations. A shoulder-cap splint is also to be recommended when the fracture is close to the head of the bone (see Fig. 47).

When this fracture is complicated with dislocation of the head of the humerus, one of two things may be done: the head may be left unreduced to be followed by a false joint, or the parts may be laid open, the head of the bone reduced, and if necessary the fragments wired together. Reduction by this procedure may be found to be impossible, and in such a case nothing short of a resection of the fractured head of the bone will be followed by satisfactory results.

Prognosis.

The prognosis as to the subsequent motion in the part in these upper-end fractures is not always clear. The repair, with its consequent new bone, will interfere to a considerable extent with the free action of the joint. In ordinary cases complete union may be expected in from four to six weeks, and it is better to employ passive motion at as early a time as the parts will permit.

Fracture at the Elbow-Joint.

Fracture at the elbow-joint is frequently encountered, and possesses points of interest inasmuch as its results will determine the future usefulness of the arm. The joint being so complex, any line of fracture extending into it must necessarily, in its repair, interfere more or less with

free motion, and it is to avert this end that every effort is directed in the treatment. Although a compound condition may be met with, the simple form is the more frequent.

Diagnosis.

The diagnosis rests on the history of the fall, pain in the part, increased size in the articulation, and inability to use the arm (Fig. 48). The sign of crepitus is rarely felt,

FIG. 48.—Typical Appearance of the Arm in Elbow-joint Fracture.

as the ligamentous structures hold the fragments in close relation. For the same reason deformity is not so common. At times a separation of the fragments can be dis-

tinctly made out, leaving no doubt whatever as to the condition. In all cases, however, in which there is a suspicion that a fracture is present, it should be treated as such, so as to err, if at all, on the safe side.

Treatment.

As regards the manner in which the treatment should be carried out, there is a diversity of opinion as to whether the elbow should be flexed or extended in the application of the dressing. The author has had better results from the following plan which he recommends. Flex the elbow

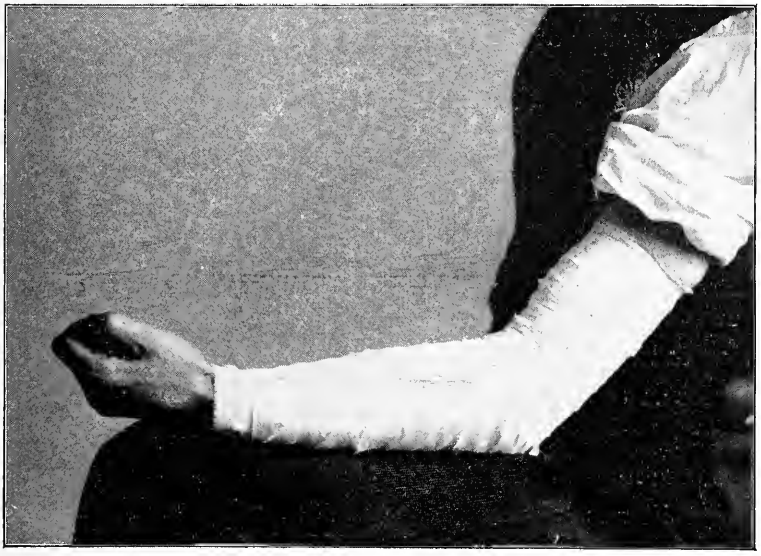

FIG. 49.—Dressing for Fracture at the Elbow-joint—semi-flexion.

to nearly a right angle, and retain it there by means of an angular splint, well padded, and supported by firm bandages and crinoline (see Fig. 49).

If there is much displacement, this dressing with proper

readjustments may be employed for four weeks, with occasional passive motion. In ordinary cases, however, when but little or no displacement of the fragments has occurred, the splint should be left on only a day or two, or until the primary swelling has subsided, and then the parts should be supported by a well-laid crinoline dressing. Passive motion should be given daily, and after a week the dressing changed to an ordinary muslin bandage, giving some freedom of motion to the parts. By so doing there is but little chance for the new bone to fill up the fossæ in the humerus, and thus limit motion. This method of treatment obtains motion at the expense of a larger amount of callus, but the latter is immaterial. This fact should be explained to the individual, however, lest he be dissatisfied because of such an enlargement of the joint.

Fracture of the Forearm.

The only point to be specially noted in regard to fracture of the shaft of the radius or ulna is the one of position during repair, in order not to have a union of the two bones at the site of fracture, with restriction of the functions of pronation and supination. With the palm of the hand in a nearly horizontal relation to the elbow-joint, this possibility is averted. We find that whether the fracture is of one or of both bones, there is often great difficulty in getting the fragments perfectly apposed by any method of extension. Especially is this true in cases in which the fracture of one bone is at a little distance from that of its fellow, and the direction of the line of fracture is oblique. An overriding is almost sure to obtain, which is very diffi-

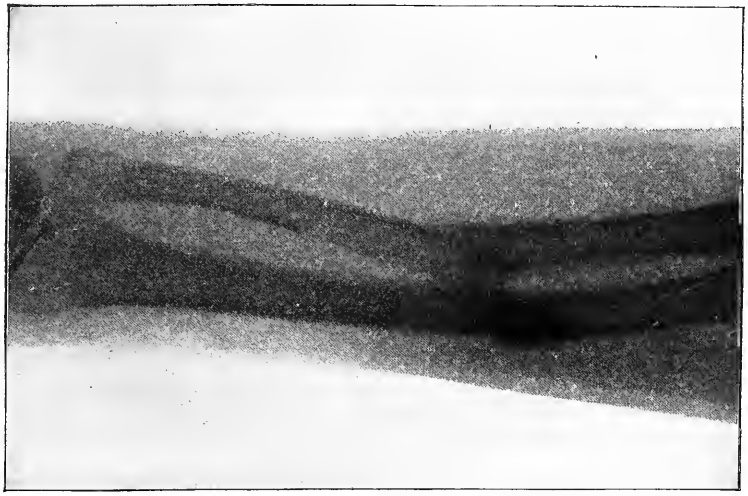

FIG. 50.—Skiagraph of Fracture of Radius and Ulna, showing overriding of the fragments.

FIG. 51.—Dressing for Fracture of the Bones of the Forearm (also used for "Colles' fracture").

cult and frequently totally impossible to overcome. Fig. 50, taken from an *x*-ray picture of such a fracture, shows this condition.

Treatment.

As to treatment, the application of straight splints to both sides of the forearm, and their retention for the ordinary period of from four to five weeks, will give as good results as can be expected (see Fig. 51). The subsequent motion is usually perfect, although some limitation in pronation frequently remains permanent.

"COLLES' FRACTURE."

In fractures near the wrist, we are most frequently confronted by that form of lesion known as "Colles' fracture."

Caused as it is by falling on the outstretched palm, the condition is an impacted fracture of the lower three-fourths inch of the radius. There is also, as a consequence, a dislocation of the ulna on to the dorsal surface of the cuneiform bone, throwing the styloid process prominently outward and backward, thus adding to the deformity (see Fig. 52). By the impaction of the radius, the metacarpal ridge is tilted, completing with the above the typical deformity known as the "silver fork" (see Fig. 53).

This is essentially diagnostic, and even if it is not always so well pronounced, it should not lead to error. Any fall on the hand, with a subsequent inability to use the wrist, with pain and swelling, should be treated as a fracture from the first instance.

Treatment.

As to treatment, inasmuch as the lesion is one of impaction, which condition produces the deformity, the frag-

ments must be thoroughly loosened before the displacement can be reduced.

An anæsthetic should be employed in every case. In order effectually to make the reduction, the forearm and

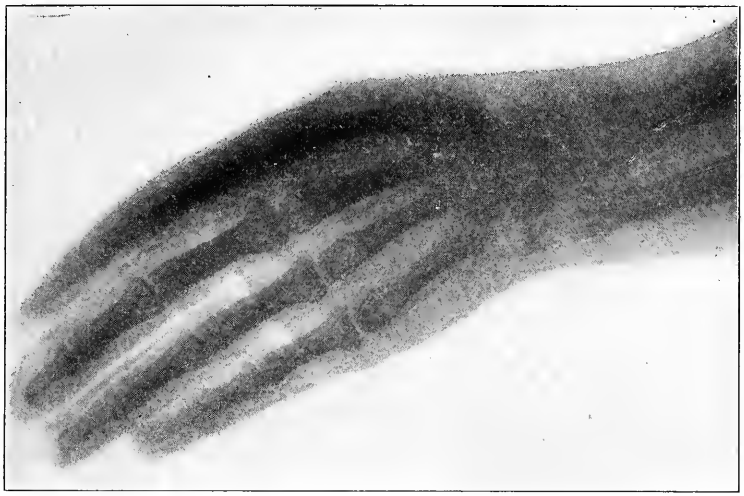

FIG. 52.—Skiagraph of "Colles' Fracture," showing impaction at the lower end of the radius and dislocation of the ulna over the cuneiform bone.

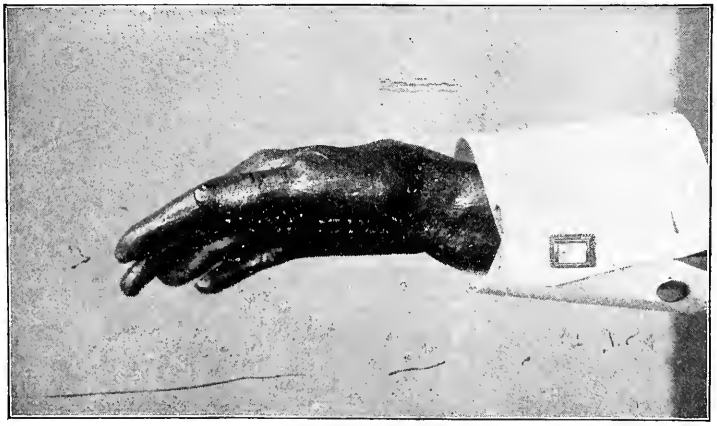

FIG. 53.—Cast of a Case of "Colles' Fracture" (before reduction), showing the typical silver-fork deformity.

hand should be firmly grasped, and by manipulating the parts back and forth the impaction may be easily broken up. Then it will be found that the parts may very easily be made to assume their normal relations, and will require but little support to keep them in such a position. An ordinary dorsal splint, well padded, serves the best purpose (see Fig. 51). Daily renewal and early passive motion should be the rule, and the result will be that within the ordinary period required for repair of bone the hand will be restored to usefulness.

Some stiffness of the fingers is apt to linger, and to become at times a painful complication. This should be anticipated by instituting free motion early, and by the application of soothing embrocations to the parts, aided by the hot pack, if the stiffness appears obstinate.

Fracture of the Femur.

Fracture of the femur is frequently met with as an uncomplicated condition. While the usual seat of such lesion is in the upper extremity, or intracapsular, yet upon the railway fracture of the shaft is most frequent.

Diagnosis.

In the latter case the diagnosis is ordinarily simple, inasmuch as the total helplessness of the individual, the pain and increased mobility of the parts, and the irregularity in size and diminished length of the thigh are pre-eminently noticeable. The tonic contraction of the muscles of the thigh causes much of the displacement, and shows as a bulging over the site of the fracture.

When fracture occurs in the upper extremity of the

bone, and especially in the neck, or intracapsular, the diagnosis is frequently obscure. However, with the history of a fall on the hip, eversion of the foot, shortening of the extremity, and more or less pain, no one should hesitate to diagnose fracture, and treat it as such, employing the method adopted in fracture of the shaft, although side splints cannot be applied. The fact that the individual walked some distance after being injured should not be permitted to weigh in evidence, since, if the fragments are impacted, which they frequently are, the power to walk might be retained for a time.

In dislocation upward, the foot is inverted and the leg shortened. Nélaton's line, between the anterior superior spine and the tuberosity of the ischium, is often of great assistance. Normally, the great trochanter just reaches this line. In fractures of the neck, the trochanter will not deviate far enough from it to be of consequence, but in dislocation upward and backward the trochanter will certainly be found reaching above it.

Prognosis.

The prognosis in fractures of the shaft of the femur is good as regards motion, but there will invariably be a shortening of the extremity of at least one-half inch, and if it is no more, this may be considered a good result. In fractures at or near the neck more than this is likely to result, and some limitation of motion in the joint as well, owing to the deposit of new bone and its consequent interference with free action. Dressings should be kept secure for from six to eight weeks, although the weight may be removed at the fourth or fifth week, and a long splint ap-

plied permitting the use of crutches, and some slight freedom of motion, gradually increasing to full use.

Treatment.

The treatment consists of extension in the line of the bone by means of weights applied to the lower extremity, fastened to the leg by moleskin adhesive plaster, while counter-extension is accomplished by raising the foot of

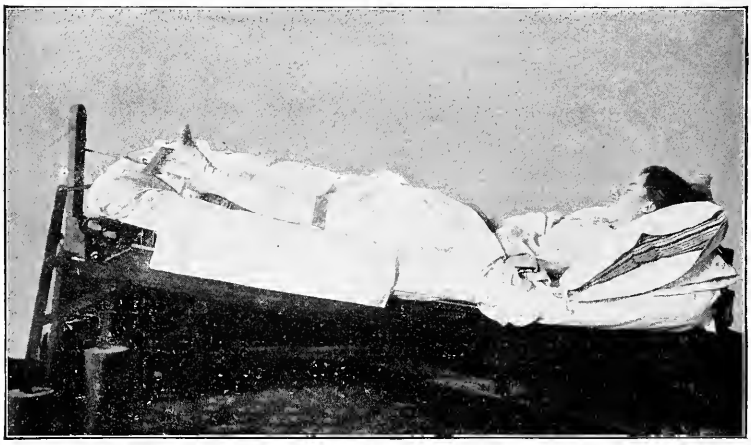

FIG. 54.—Dressing and Apparatus for Fracture of the Femur.

the bed (see Fig. 54). Thin side splints should also be applied over the site of fracture, well bandaged on, and supported by sand-bags on each side.

FRACTURE OF THE PATELLA.

Fracture of the knee-cap is uncommon in railway service, yet when it does occur it signifies as much as, if not more than, many more serious lesions, for the repair of this injury must be nearly perfect in order to permit the

individual to re-enter the railway service. The outcome of the vast majority of these cases has been stiff knees, and therefore it remains for the surgeon to use every endeavor to secure the best possible result.

Diagnosis.

The diagnosis is usually made by the individual, for he describes the fall, with the crack in the knee-cap, and the subsequent helplessness. Examination shows a transverse division, more or less complete, of the bone at its centre, accompanied by swelling, which may become large owing to the rapid effusion of blood into the capsule, the usual result of the injury.

Treatment.

Many are the devices for the treatment of this condition, and the question, with the author, always shapes itself on the amount of separation of the fragments and the effusion in the capsule. When the effusion is profuse there is usually a wide separation, and this is the most frequent form met with. When the separation is incomplete, and the fragments are held by the fibrous and ligamentous structures surrounding them, any one of the usual forms of dressing may be employed.

Attempts to appose the fragments by posterior splints and figure-of-eight bandages applied to a fully extended extremity, and subsequent retention of the latter in a horizontal posture for a period of five or six weeks, will usually be followed by a fair result. Passive motion may be attempted at an early period, carrying it as far as possible in the line of flexion of the joint.

When there are wide separation of the fragments and a large effusion of blood within the capsule, any attempt at obtaining apposition by external dressings has proved an utter failure in the experience of the author. In such cases it is advisable to perform an immediate operation by making an elliptical incision over the knee into the capsule, to clear out all the blood clots, and after adjusting the fragments properly, to secure them in position by silver-wire sutures. The periosteal and ligamentous structures should be drawn together with a row of buried silkworm-gut sutures, both to afford additional support and to preclude the possibility of these tissues getting in between the fragments. The external wound is now closed, and a bulky, soft dressing applied, rendered immobile by several layers of crinoline and a posterior splint. Healing by first intention should be secured, when after from three to four weeks the immobile dressing may be discarded and passive motion commenced. Support should still be obtained by a figure-of-eight bandage well applied, to be followed after a week or so by an elastic knee stocking.

Several cases treated by the author after this method have been followed by results that were beyond criticism. Mechanics and laborers were included in the number, all of whom returned to their occupations with perfect motion in the joint.

In one case in which silk was employed for the bone sutures, these came away through self-made sinuses, some after two, and some after three years' time. In the others in which silver wire was used, nothing has been noted from them.

Fracture of the Tibia.

Fracture of the shaft of the tibia alone is usually the result of direct violence, and for this reason it is more apt to be compound. Simple fracture would be caused by leverage acting within the length of the bone.

Diagnosis.

In simple fracture the diagnosis is usually easy to establish, as the shin is so superficial that the line of the bone can be traced from one extremity to the other, and any deviation or depression readily discovered.

The usual signs of fracture, as crepitus, inability to use the extremity, pain, and deformity, are present, and very few cases are at at all masked.

Treatment.

In the treatment, the dressings should be simple, but effective in keeping the bone in its proper position and line. If the fibula be uninjured it will assist as a splint to keep the bone extended. When the fibula is also implicated, and the line of fracture is oblique, there may be some difficulty in keeping the bone extended to its proper length. A moulded posterior splint, of rigid material, perfectly fitting the contour of the calf and ankle, and reaching above the knee and including the foot, will answer as an ideal dressing to retain the fractured bone in proper position (see Fig. 55).

Frequent inspection should be made, as in treating all fractures, to observe the condition of the fragments.

If not comminuted, fractures of this bone readily unite,

and may be given freedom from the dressings in from four to five weeks.

Prognosis.

There is very little to fear in regard to a perfect result

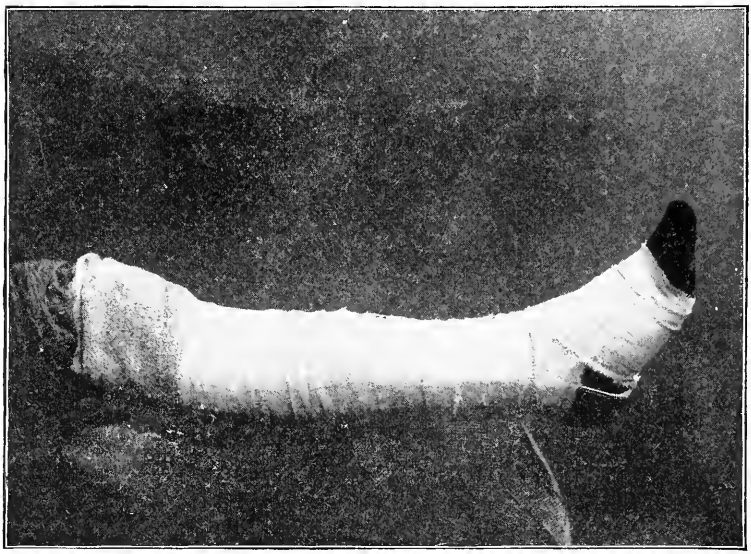

FIG. 55.—Dressing for Fracture of the Tibia (or tibia and fibula).

ensuing, and complete and free use of the leg is the usual outcome

"POTT'S FRACTURE."

The fracture at the ankle characterized as "Pott's" is particularly spoken of on account of its great frequency among persons who get off and on cars that are in motion. A slip or twist of the foot carries force against the malleoli, and one or both are fractured, the outer one usually carrying with it the lower inch or two of the fibula. This permits the foot to lose its relations with the ankle, and to become everted to a very marked degree. Usually there

is also a dropping backward of the foot beyond its normal line with the leg.

Diagnosis.

The diagnosis of this condition is self-evident from the deformity caused by it. The lateral ligaments, being ruptured or badly stretched, permit the foot to retain the deformity produced. Pain and inability to use the foot will be strong subjective symptoms, while the deformity, crepitus, and palpation of the fragments will be positive objective signs.

Treatment.

The treatment of these fractures consists of perfect replacement of the dislocated foot, and the proper adjustment of the fractured processes. The latter will be seldom "out of place," by reason of their ligamentous attachments being close, so that upon the return of the foot to its proper relations with the leg and ankle these processes will be found assuming their normal positions.

The great difficulty is in keeping the foot where it belongs, its great tendency being to drop backward, and in this the tendo Achillis has considerable influence.

After extending the foot downward and inward until the malleoli, especially the external one, are felt to be in proper position, a splint should be applied that will retain it there. One that supports the calf and envelops it, as well as the entire foot, will be found most advantageous. A plaster-of-Paris mould may be applied so as to enclose the entire leg and foot, and upon hardening it should be immediately cut open down its front side, thus making a cradle in which the whole extremity will rest securely

(see Fig. 56). Pads should be well applied around the processes and heel. This open mould can be secured by a roller of crinoline, and in this wise frequently inspected. Daily observations should be made for a time, to ascertain the position of the foot. It is advisable to retain such a

FIG. 56.—Plaster-of-Paris Mould for treating "Pott's Fracture"; showing the dressing slit open, ready for bandaging.

dressing for four or five weeks, after which a support can be secured by means of an elastic stocking. Passive motion should be instituted as early as the case will permit, but complete freedom withheld from the foot until assured of complete union. There is a great tendency of the resulting deformity in these cases to increase upon use of the foot. In fact there are not many fractures that will be followed by so much and so ugly a deformity as "Pott's." Patients should be particularly advised regarding this probability, lest the surgeon be subsequently censured.

CHAPTER XIV.

CRUSHES OF THE EXTREMITIES.

HAVING considered ordinary wounds, as well as those associated with compound fractures, attention should be drawn to crushes of the extremities, which will be understood to mean the injuries caused by being run over by one or more cars. When such an accident has actually occurred it can be assumed that the distal extremity is irreparably destroyed, while in numbers of these cases the part is entirely severed and gone. Even if it is still attached we can presume it to be as good as gone. When it is considered that, in the minimum, some fifteen tons (the weight of a single empty flat car), and probably more than this, up to several hundred tons, has been the crushing force, we could not expect any other result. There are cases in which, in spite of this enormous weight and total destruction, the distal part still remains attached by sufficient tissue to lead an ordinary observer to think it possible to retain the injured part.

The history of the accident is first necessary, and while the surgeon should be painstaking in collecting this, he should not place too great stress upon it. We have stated that we cannot decide by the history alone, nor even by the appearance of the part, but we must look carefully into the matter before arriving at any conclusion. It has been previously observed that the exaggeration in the reports of

the bystander, concerning the manner of production of an injury, is likely to be flagrant, and that the speed at which the train was going is a very important question to be clear upon. It is necessary to know not how many miles an hour, but whether the train was running at full speed or just moving along, as in starting or stopping.

These two extremes have much to do with the question of the damage produced, and are therefore of the utmost importance to be elucidated. Of course, when the distal portion is cut off entirely, this fact stands as a positive condition without questioning, and signifies that the injury was caused by a fast train, for a slow one does not cut off the part completely, but leaves it in a more or less mangled condition

Appearances, and Diagnosis.

Now let us see how extremities look when so injured. In cases in which the distal part is entirely cut off, the proximal end will be found ragged and torn, the bone probably somewhat protruding, and splintered, with a portion of the muscle hanging in a blackened, shredded condition from the end of the stump (see Fig. 14). The skin adjacent and above is usually scratched, ecchymotic, and bruised. The next class, in which the distal part is still attached, will present as a complete crush through the extremity, pulpifying the soft parts and comminuting the bone. The skin is torn and loop-holed, through which blackened muscular structures bulge. The remains of the extremity, being flail-like, and the usual complement of soiled clothing of the part and the rubbish of the road, with which all is mixed, and the hand or foot (as the case

may be) twisted upon itself among the *débris*, make a picture quite appalling (see Fig. 57).

There are cases in which no such mangling is found, the contour of the part being but little if at all changed, a line of bruised or ecchymotic scratches marking the loca-

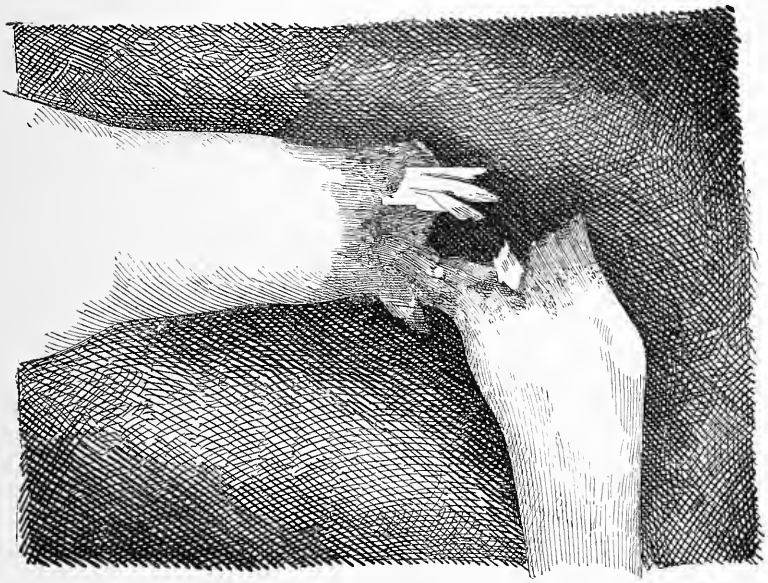

FIG. 57.—Crushed Extremity, showing destruction of the tissues, with distal portion still attached.

tion of the injury, with perhaps a buttonhole or two through the skin (see Fig. 12). If this condition is found when a fast train has passed over the part, closer investigation will prove that all beneath the skin is a mass of pulp, and the fact that the outer covering of skin keeps itself intact is one of the peculiar conditions frequently found, serving to mask the true destruction. Since a case in which the normal contour is preserved may be one of those in which the extremity, caught by a car wheel, has

been slid out of the way without being actually impinged, in spite of the history that it has been run over, the parts must be examined closely and satisfactorily so as to elucidate the true condition of things.

When the part is devitalized, the remaining end will be pale, cold, pulseless, and without feeling, although in a few instances slight motion can be effected through one or more tendons not yet divided. Palpation and manipulation usually aid greatly in a solution of the question, as loss of firmness and a flail-like condition at the point crushed will be prominent. The finger introduced through slits in the skin will reveal the true condition, as it can be passed in any direction through the pulpy mass, and feel the bone in its comminuted state.

Complications.

An injury as severe as this is always accompanied by complications, of which shock is the most prominent. The preponderance of this state depends in a great measure upon the severity of the damage done the tissues. Great mangling is accompanied by the severest shock. A few cases are met with in which this condition is not present to any degree whatever, and aside from some pallor or rapid pulse, none of the usual symptoms is seen. These are cases, however, in which the hemorrhage has not been great, and in which fright or psychic influences have not presented themselves. It does not follow that these cases will stand operation better than those in which depression is more marked, for there is a probability that the shock will come on suddenly at a later moment.

When this does occur, a secondary shock, or explosion of nerve force, is considered the cause, and is rather difficult to combat.

The next complication or rather associated condition in these severe injuries is that of hemorrhage, which may be severe, and also influences shock to a great degree. Although easily controlled, it is in the few moments of its existence, however, capable of devitalizing a man beyond recuperation.

An unconscious state is next to be considered, and the question to be determined is whether it is caused by the effects of the injury *per se* or by lesion of the brain. When shock is present, with a cold clammy skin, it must, in the absence of local signs of head injury, be looked upon as the effect of the visible injury. When a scalp wound is present, with no apparent evidences of skull fracture, this must remain the conclusion, until later developments prove otherwise. When fracture of the skull is present without question, the unconsciousness may be ascribed to that, as it is more liable to be the cause than the crush. One needs to look carefully into the symptoms, and work assiduously to make a differential diagnosis so as to be sure of the exact state present.

First-Aid Treatment.

When a man with a crushed extremity is first seen alongside the railway, it does not become the surgeon to take up too much time, even with the important matter of differential diagnosis, but he should attend to the progressive conditions, whose continuance will add much to the seriousness of the case. Therefore, personal care of the

wounds should be the first mission; that is to say, a temporary treatment must be adopted until the man is placed in a position where the line of permanent and radical treatment can be properly instituted.

The first steps in the treatment are as follows. Stop hemorrhage, give stimulants, and dress the wound. Give a full dose of morphine hypodermically to quiet pain and thereby reduce the degree of shock. Next hastily examine the crush. If the extremity is entirely gone, put an elastic bandage as close to the end as possible, tight enough to stop all bleeding. If the distal part is still hanging, place the bandage firmly just above the injury. If but a few shreds hold it on, snip these off, and finally apply a large absorbent dressing. This is done, of course, right on the spot where the patient lies injured, and takes but a few moments. Frequently it is found that an improvised tourniquet has been already applied by his fellow trainmen, as well as a goodly amount of whiskey given.

Transportation.

Now comes the question of transportation. Is the man able to be removed at all, and if so, how far? If an entire extremity has suffered, no further transport should be imposed upon the patient than the nearest shelter where warmth can be obtained, and where he should be given every attention necessary until recovered sufficiently to bear removal. Remember that the jostling, exposure, and excitement consequent upon transportation have been the cause of mortality in many cases. If but a foot or a hand is the part involved, the man is conscious and capable of

carrying himself, and the point of destination not too far away, he may be transported after having received the necessary attentions. As to the question of operation, if the shock is moderate, the skin dry, and the necessities demand it, it may be done at the place of temporary shelter, and before transportation.

Treatment.

The temporary treatment of these cases is covered by the general directions for the care of wounds: thorough cleansing with turpentine, hot water, soap and brush, and shaving if necessary, arrest of hemorrhage, drainage, bulky and absorbent antiseptic dressings, and over all a bandage and a splint as supports.

The radical treatment is amputation, and the rules for this, as well as the technique, will be elaborated in a subsequent chapter. Bear in mind that the radical operation should not be too hastily done. While it may be proper to operate at once if the physical condition permits, yet remember that two or three hours are not wasted if given to getting the man in shape, and procuring assistance and materials in order to do the best possible for the case and to divide the responsibility among several others. This line of action is especially valuable in cases in which the distal extremity is still attached, for there will often be one or more spectators present who will declare it to be improper to amputate. After the amputation the patient will have to be kept quiet for a time, but his removal then is to be considered much less risky than were it done with the crushed parts still attached.

When an unconscious condition is present, and yet it

becomes necessary to do a radical operation then and there, do not wait for the head symptoms to clear up, if the other conditions are favorable; but here an anæsthetic can usually be dispensed with.

Double Crushes.

In case of double crush when two or more extremities have suffered, the gravity of the case is vastly increased. Extra precautions and efforts will have to be made to combat as much as possible the increased complications. Remember that time is an important factor in the care of these cases, and the quicker the application of the various remedies and expedients for controlling the conditions, the sooner will the patient rally.

These are cases in which it is imperative that transportation be left out of account, and every attention paid at the nearest shelter. The shock in double crushes is considerably more severe than in the case of injury to one extremity, and the necessity for a radical operation or amputation must be considered in a more serious light than if but one limb is affected. It is sometimes wise to have two surgeons operate simultaneously in such cases in order to save time.

Prognosis.

The prognosis in crushes of the extremities depends upon the severity of the mangling, the complications of shock and hemorrhage, and the strength and age of the individual.

The young ordinarily stand such injuries well, and will

recover. Old men frequently succumb, especially in cases of double crushes. Of course when a complicating condition exists, and a vital organ is implicated, the whole aspect of the case changes under the influence of the latter lesion. If transportation has been resorted to in a bad case, it will add very materially to the unfavorable prognosis. Prompt care and treatment modify, to a great degree, the question of prognosis in uncomplicated cases, and if properly given will be followed by a very large percentage of recoveries.

CHAPTER XV.

INJURIES TO THE HAND AND FINGERS.

THERE are particular reasons why the subject of injuries to the hand and fingers should be taken up in a special chapter. The hand is the organ of prehension, and by its use the laboring man and mechanic must earn his daily bread. One-third of all injuries received upon the railways are lesions of these parts. There are reasons, therefore, for giving this region particular consideration, so that we may be able to render those so injured the best possible service. The hand is very vascular, and recuperates quickly from injury, so that nature aids us in accomplishing good results from well-directed efforts.

Degrees.

We find these injuries to be of all degrees of severity, from the simple bruise or contusion to the complete pulpification of the whole hand. In extent, there may be only one finger implicated, or a number of these, including portions of the hand. The thumb escapes in a large proportion of cases, the ulnar side of the palm, with the fingers of that side, being more frequently caught. The palm or dorsum of the hand may be wounded, and be associated with fracture of some of the metacarpal bones, or the wound or fractures may occur with any complication.

Causes.

These injuries are for the most part caused by the hand being caught between the dead-woods, or bumpers, while in the act of coupling cars, and are seldom caused by other means. When fairly and squarely so caught as the cars come together, there is no hope for the part impinged, for the force is sufficient to completely destroy its vitality. But it is very frequently the case that portions of the hand or fingers are only pinched or squeezed by the coupling pin, or by the draw-bars, or the parts that hold the pin, since these always come together, while the bumpers at times do not, on account of their varying form in the many cars that make up the ordinary train. This then leaves a space in which the hand or fingers may become squeezed, but not crushed.

Appearances.

The vascularity and irregularity of outline of the hand make a crush or injury which has torn the skin look at first sight far worse than it really is. When the skin remains unbroken, there will be a swollen, ecchymotic condition, with inability to use the hand, pain, and extreme tenderness. There may be a buttonhole or two in the surface, or there may be abrasions through the skin of the part. A finger may be squeezed so as to divest the phalanx completely of its soft structures, leaving the bone protruding, or the latter may be broken or comminuted, and be surrounded by torn skin and mangled tissue (see Fig. 58). If the injury involves the palmar or dorsal region, tears

of the skin will reach up into it, uncovering the tissues of the part. In bad crushes, the parts are mangled beyond anatomical distinction, joints disorganized, bones comminuted, and tendons twisted about all the *débris*. Hemorrhage is usually severe owing to the large blood supply of

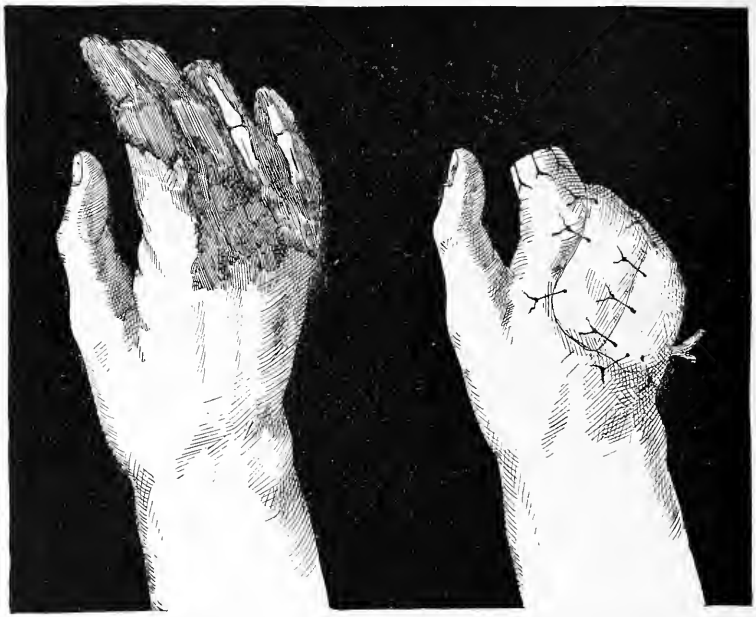

FIG. 58.—Illustration of Crushed Fingers, showing the denuded phalanges; and the scheme for employing the skin from the same for flaps to cover over exposed areas.

the hand, but as a rule consists of general oozing rather than arterial bleeding, unless the palmar arch is injured.

Diagnosis.

As to diagnosis, there is usually but little difficulty. When the wound is severe, it is of course simply a matter of decision on sight. When the skin is but contused or unbroken, it behooves us to look somewhat closer. It can

be assumed, however, in these cases, that the injury is but a squeeze, and, beyond the possibility of fracture in one or more of the bones of the hand, that the soft structures have escaped destruction. When simple fractures of the phalanges or metacarpal bones are present, the signs are usually determined without difficulty except in fleshy palms. Here the *x*-ray should be made use of if possible.

Prognosis.

As in all railway practice, however, diagnosis and prognosis should be especially guarded as regards recovery with good motion. We must remember that the processes of repair which ensue after an injury, no matter how slight, often serve to glue the tendons and muscles together to such a degree as to limit their motions considerably, so that a perfect result cannot be assured, even after what appears to be but a slight squeeze. Much less is this so in bad injuries or crushes. The individual should be assured that the best possible will be done. and he must abide by the results.

Treatment.

In injuries of the upper extremities, especially of the hand or arm, we would advise conservatism to a greater extent than elsewhere. The fact that the hand is the organ of prehension being borne in mind, it should be given every chance. Here the old rule of "save all you possibly can" is a very proper one. These lesions, being mostly bumper accidents, are classed with the slow-train injuries, and the damage done is limited to the margin of the wound as observed, and does not extend beyond it. More

than this, the shredded skin flapping loosely about can be brought into use in repairing the damaged extremity. These cases are rarely complicated with other lesions, and are not found associated with shock or loss of consciousness, the individual being able to carry himself. It should be remembered that on account of the great vascularity there is also a large degree of absorption possible, and as the hand is invariably septic, the sooner all influences for bad are removed and the part is put in permanent shape for recovery, the better are the chances for a good result.

After applying an Esmarch bandage above the wrist, one may begin to clear up, and it will usually be surprising to find how much washes off, that is to say, how much better the chances for a result appear after the blood and *débris* have been cleared away. It will usually be necessary to give an anæsthetic in order to do all this properly, for the scrubbing of torn skin is painful, yet must be thoroughly done, and whatever is called for in an operative way can be accomplished at the same time. When all is clean (and here it is that the spirit of turpentine comes in play as a valuable cleansing agent), take a pair of scissors and trim off the mangled tissues, and with the bone forceps chip off the ends of the fractured bone, or separate them at the articulation with the scissors.

Anticipating the possible use of some of the shreds of skin to cover over denuded areas, be careful not to cut off such as may be thus employed until the plan is decided upon and mapped out (see Fig. 58). A little patience and ingenuity will do this to a degree of nicety, always allowing for the shrinking of the flaps through the elasticity of the skin.

Now as regards what is to be left. If a finger is crushed down to the metacarpal bone, it should be removed altogether, and with it the head of the metacarpal bone that it articulates with. This will permit the hand to assume a better shape subsequently (see Fig. 59). If an entire phalanx can be saved in the index or middle finger, it is best; but no special effort should be made to spare such in the ring or middle finger, as experience proves that it

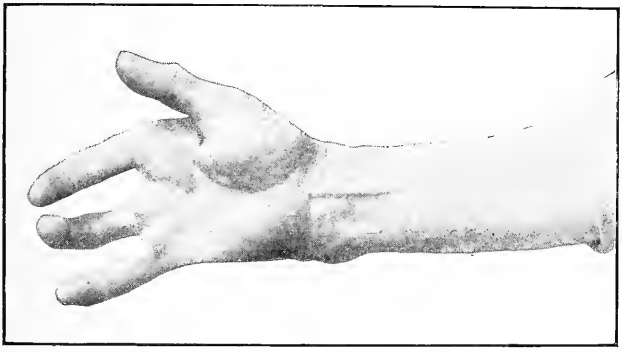

FIG. 59.—Loss of Entire Finger, and removal of head of metacarpal bone.

is invariably in the way afterward. When a phalanx is left, the flexor and extensor tendons should not be cut off close but left long enough to be united over the end of the bone, thus giving a degree of motion to the stump which would otherwise be a useless stub (see Figs. 60 and 61).

If all the fingers are gone, and the palmar or dorsal surface is exposed, utilize all the available skin from the torn fingers, if necessary to close over any gap left in the parts to be preserved. By peeling the skin off the phalanges or bones, quite a covering can be obtained, and even if this is not enough, the rest can be permitted to fill

in by granulation, the surgeon being particular to see that the tendons are covered either by natural or transplanted

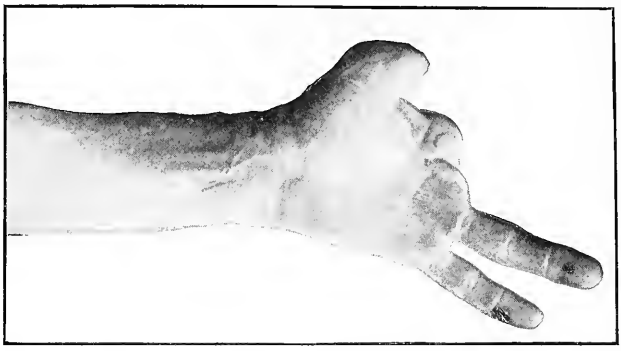

FIG. 60.—Phalanx of Thumb remaining and treated by uniting the flexor and extensor tendons over the end of the stump.

skin. A few sutures may be inserted at points where necessary to retain the flaps in their new relations, plenty of loopholes being left for free drainage (see Fig. 58).

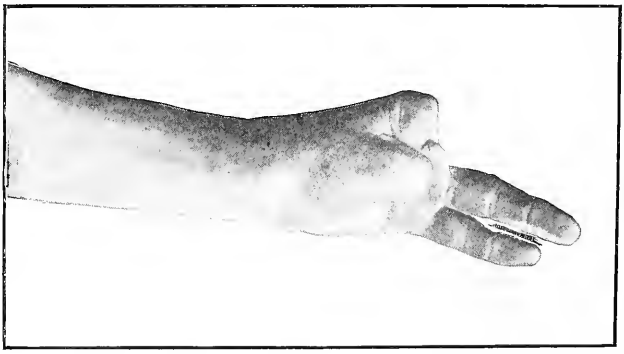

FIG. 61.—Showing the freedom of motion attained in the case depicted in Fig. 60.

After the parts have been thoroughly washed with bichloride solution, and plenty of hot water has been used, a firm dressing consisting of many thicknesses of gauze

and a snug bandage should be applied. As a rule ligatures will be unnecessary, except when the palmar arch has been injured; but if the Esmarch bandage has been left on until the firm dressing is well applied high up over the

FIG. 62.—Result of Conservatism in Injury to the Thumb. Resection of proximal phalanx. (Case of Dr. F. A. Palmer.)

wrist, the consequent bleeding will not be enough to soil the dressing. This obviates the difficulty of searching for the small vessels in the torn tissues, and saves much time.

Now a word as to the thumb. A hand without a thumb

is scarcely a hand at all, while a fingerless palm with a thumb is far better, for upon the latter the grasping power of the hand depends. Therefore all efforts possible should

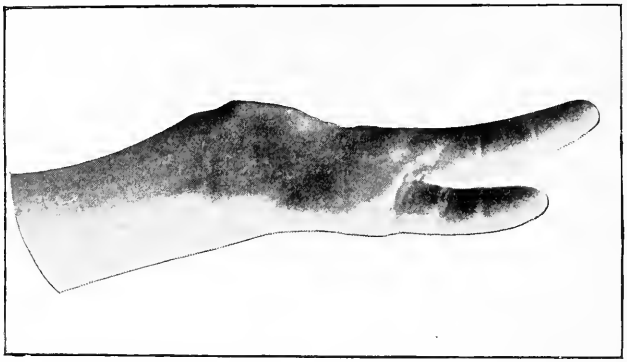

FIG. 63.—Loss of Thumb, Index, and Middle Fingers. (Case of Dr. F. A. Palmer.)

be made, in case the thumb is injured, to save every fraction of it. Even if it is necessary to attempt to cover over denuded bone, or to stitch down tendons that are torn from

FIG. 64.—Showing Freedom of Motion attained in case of FIG. 63.

their sheaths, in order to preserve this part, it should be done. It is better to risk a subsequent amputation, but a stiff thumb will serve more of a purpose than no thumb at all, and is even worthy of an effort (see Fig. 62).

Time works wonders with stiff fingers, and patients discharged with very limited motion will, in a year or so, limber up to an almost incredible amount of motion. Figs.

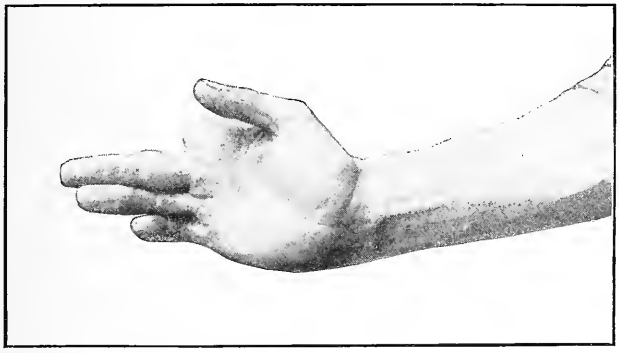

FIG. 65.—Loss of Index-finger.

63, 64, 65, 66, 67 and 68 are illustrations of cases of injuries to the thumb and fingers in which conservatism was

FIG. 66.—Showing the Perfect Flexion in case of Fig. 65.

practised. The results show the benefits derived from such practice.

Now as regards the hand as a whole. In cases of crush, it becomes necessary to sacrifice all that is pulpified, and

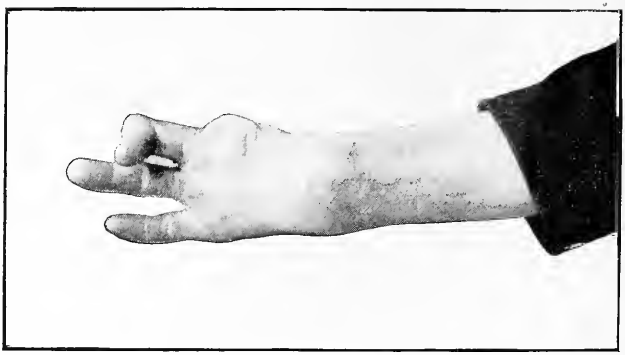

FIG. 67.—Loss of Thumb and Index-finger, in which case there was much injury done to the middle finger.

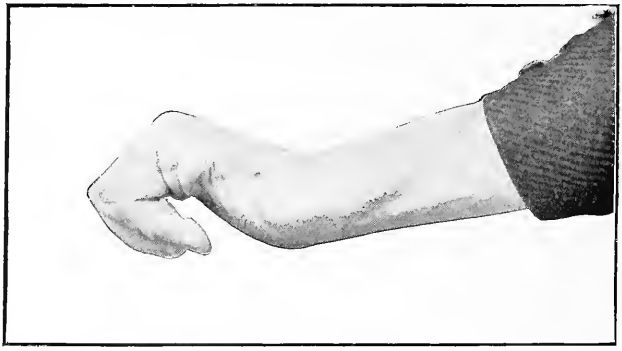

FIG. 68.—Illustrating the Amount of Flexion which resulted in the case depicted in Fig. 67.

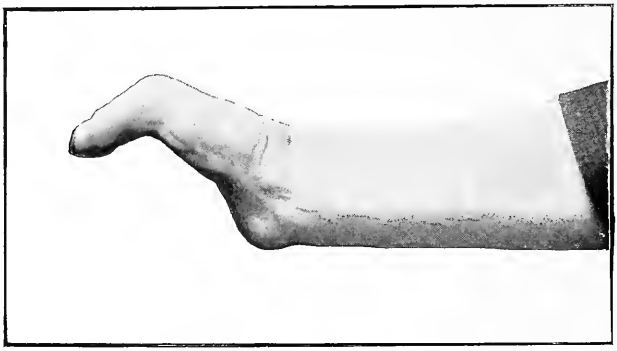

FIG. 69.—Loss of the Entire Palm, showing the uselessness of the remaining thumb.

this may be found to include the entire hand and thumb. At times the latter escapes, even when the whole of the palm is destroyed. In such a case it is unwise to attempt to save it, as without a palm it would be but a useless appendage, much in the way (see Fig. 69). If any portion of the palm could be preserved with it, the efforts to save both are proper; but if not, a clean amputation just above the wrist should be made. When we leave the domain of the fingers and palm, we return to the rule that ultra-conservatism is unwise, and must then look for the best stump on which to affix an artificial member. An artificial hand is of but little service, but for the looks of the thing many desire to wear one.

As to the treatment of those cases that are not crushed, but simply bruised or squeezed, they must be cleaned up with equal thoroughness, and if any buttonholes exist, antiseptic solutions should be forced into their depths, after which the hand should be enveloped in hot fomentations for several days. If the parts are ecchymotic or swollen to a tense degree, make several incisions parallel with the tendons down into the cellular tissue and over the swollen part, to permit of the outflow of exuded fluids contained therein. This procedure often marks the turn of an unfavorable case into the channels of recovery, and in any case in which operation is not called for, such incisions may properly be done if much tension is present. As to the detection of deeper damage in these cases, it is a matter of conjecture while the swelling exists, and they should therefore be well supported on splints, in anticipation of such a condition. The *x*-rays are now a very valuable adjunct in determining this matter so far as the

bones are concerned, and should be employed when at hand.

These latter cases always demand very careful watching, because of the possibility of subsequent conditions arising to deflect the case into serious channels. Complications may occur in any hand injury, and one especially to be feared in contusions is that of a phlegmonous condition, which, induced by sepsis, comes on insidiously, creeping up the sheaths of the tendons, appearing in the palm, and even above the wrist. This is announced by constitutional symptoms of chills and fever, and local swelling and tenderness. Such a train of symptoms then should call for immediate attention, the distal wound being opened, and free incisions made wherever tumefaction appears. A thorough washing out with dioxide of hydrogen, followed by drainage, should be directed to combat the condition. Tetanus is rarely met with in railway injuries of the palm, and should not be feared.

Daily redressings should be the invariable rule for all these hand injuries. The surgeon should never trust to the antiseptic to do the work, but be ever watchful, knowing that from being primarily septic they are prone to grow worse; and while a larger number of them heal rapidly and completely, yet it is by granulation, and not by aseptic union, so that pockets may readily be formed, inviting the burrowing of pus. In the redressings it may be necessary to snip off small bits of tissues which have lost their vitality and have become necrotic. Care should be taken that all pus is carefully removed from the interstices, and the surfaces and pockets are well washed out at each daily dressing. Such sutures as were used may be

removed in a day or two, and the thick horny skin which usually peels from the proximal parts carefully taken away as soon as loosened.

Passive motion should be early instituted, and daily motions of a gentle character to the parts serve well to obtain freer motion.

The rules for transportation in injuries of the hand and fingers need only be carried to the point of restriction in case of unconsciousness, or when other complications exist in the case to give it a serious aspect. Otherwise, as soon as all is dressed, and the individual well out of the anæsthetic (which would be in from two to four hours), he can be sent by conveyance to any desired point.

CHAPTER XVI.

THE WHY, THE WHEN, THE WHERE, AND THE HOW TO AMPUTATE.

The Why to Amputate.

Any operation that has for its purpose the preservation of life is certainly proper and justifiable, and while its performance is an important element in any given case, it may prove either beneficial or destructive. Not only are parts amputated to save life, but to preserve function. It is not in cases in which, after a railway train has passed over an extremity severing it entirely, or essentially so, that the call for the operation comes up, for here any bystander recognizes the condition of destruction, and the propriety of any subsequent performance of the surgeon regarding the trimming off or amputation of the extremity is not questioned. In other cases, however—and such are frequently met with, as already described—the contour and appearance of an extremity are such as to impress the ordinary observer with the belief that it can be saved.

We know that in leaving an extremity whose vitality is crushed out beyond doubt, we leave a condition of great danger, and one whose destructive effects, both locally and constitutionally, manifest themselves rapidly. With disintegrated tissue, which softens and decomposes quickly, in direct relation and communication with the absorbents

in contiguous uninjured parts, it only remains for the latter to take up from the injured area the fluid effused, replete with septic agents, and to distribute it through all the susceptible organs of the body. We are aware how rapidly the systemic effects of sepsis show themselves, and how quickly a rise of temperature, rapid pulse, failing strength, chills, pallor, sweating, and other signs of poisoning follow, all of which are destructive to life. In case of an extremity whose vitality is not completely crushed out, the part may survive, but around the crushed area are portions of destroyed tissues which may eventually produce the same dire results.

In cases of complete severance, the railway car does not do an ideal amputation. The bones are jagged, the tissues torn and ragged, all presenting an irregular line, to which is attached much that is entirely lifeless (see Fig. 70). We amputate, or rather re-amputate, in these cases, in order to reconstruct such a surface into a well-formed, clean, and healthy stump. These, then, are some of the reasons why we amputate to save life.

We also do these operations to preserve function. To leave an extremity whose usefulness is beyond repair by reason of extensive loss of bone or muscle, even though capable of retaining its vitality, is not good surgery. Especially is this true of injuries to the lower extremities. A foot squeezed so as to comminute the bones of the ankle may be followed by an enlarged, stiff, useless foot, whose limitation of movement renders the person almost incapable of locomotion. A bad compound fracture of the leg, especially if encroaching upon the knee-joint, may result in necrosis of the epiphysis or sloughing of muscle and

fascia, due to limited circulation, and finally in a totally useless extremity.

In the upper extremity, this being the organ of prehension, we save all we can, but still amputate to save

FIG. 70.—Proximal Portion of a Crushed Extremity, showing the ragged appearance of the tissues.

function in the same way. A judicious line of amputation is always called for in surgery of the hand and fingers in order to give the greatest motion with the least loss. Every case here, as in those which are badly crushed, is a law unto itself to some extent.

Lastly, we amputate on purely conservative grounds in order that poor men may be shortly returned to their families and work, instead of worrying through a long period of time in a vain attempt to preserve that which has been all the time past saving.

The When to Amputate.

The question of when to amputate has been already noted, and should be easily comprehended when a part is irrevocably destroyed. The sooner this part is separated from the body the better, at the same time taking into consideration the period when in that particular case there will be the least risk of life.

There are differences of opinion as to whether we should wait, or do an immediate amputation, in cases requiring it. The time for amputation in cases of injury is divided into the primary or immediate period; the intermediate, or some hours or days after injury, when the inflammatory stage is reached; and the secondary, or after all subsidence of the acute inflammatory processes.

The shock which accompanies all these severe injuries is usually the point upon which the division of opinion hinges as to the proper period. Some believe that it is better to operate even in shock, thinking that the benefit to be derived from ridding the body of a shock-producing condition is less risky than to allow the case to go on for hours awaiting what may never come, a more favorable opportunity.

Suffice it to say, as has been noted before, that no operation should ever be undertaken while the patient is

in collapse; but that when we talk of or advise operation, it is with the understanding that the patient presents a fairly good, regular pulse and respiration, with a dry skin. He may be in shock, and yet be able to stand an operation; in collapse, never. Here we must wait until it is seen without a doubt that the patient is rallying.

It is our opinion that a primary operation, done within six hours of the injury, is the proper time for such, proven by the accumulated experience of our own and other railway surgeons' practices, in which such a procedure has been adhered to for years. We have never lost a patient after amputation near enough to the time of operation to believe that the amputation *per se* was the cause of his death.

The close relation of military surgery to railway surgery will permit us to take the experience and advice of military surgeons quite into account in considering the propriety of practice in railway cases. Among the surgical operations in the War of the Rebellion we find 12,246 primary amputations out of 19,970 cases, and the results range from 6 to 14 per cent better. Of 3,665 cases Ashhurst secured 13 per cent better results by resorting to the primary operation, and advises the latter procedure.

Now while many of these figures relate to the days before antiseptic surgery, yet since the latter advent, the relative mortality following primary and secondary amputations has not been materially different; but rather in favor of the former procedure. As a result of ten years' amputations for traumatism at the St. Thomas Hospital, London, the mortality was half as great in primary as in secondary amputations.

In addition to these argument, in support of our position in advising primary amputations in traumatic cases, we can always consider the risk to life involved to a greater degree when prompt action has been delayed.

Again, some individuals will more readily give consent to the removal of a mangled limb at the time of injury than later on. When recovering from the immediate dangers of the injury, a patient's courage often fails him and he submits to carrying about a useless, unsightly part, to the total deprivation of comfort or labor, rather than to have anything done, although wishing that he might be rid of it. Operate then at once boldly and without reserve when satisfied of the necessity for such action. One will thereby save more lives, save more tissue, lessen complications, and have better final results as to function.

While shock must be regarded when profound, it should be remembered that it sometimes comes on to a greater degree some hours after the injury, on account of the continuance of conditions associated with the injury, as hemorrhage, pain, and sepsis. Patients invariably improve after relief from these shock-producing conditions, and finally as the weight of opinion of operators throughout the world is on the side of primary operations, or amputations within six to ten hours following injury, no one should be at a loss to decide, When shall we amputate?

The Where to Amputate.

We have given ideas as to why there should be a choice in the matter of the line of amputation in railway injuries. There is no fixed rule in the matter save that

which is determined by inquiry into the cause, and its relation to the effect produced.

Fast-Train Crushes.

This question refers us back to the early remarks concerning the division of railway crushes into fast-train and slow-train injuries. It was shown that a fast train not only entirely severed the extremity, or mangled it beyond repair so far as the distal portion was concerned, but that the force in play destroyed the tissues above the lines of apparent injury; that owing to the plugging of the main vessel, thus reducing the vitality of the parts contiguous to the lesion, the fact was certain that these tissues would not be capable of restoration, and must therefore be considered as of the distal part. This was in spite of the frequent normal appearance of the parts.

Each of these cases must be a law unto itself, but as a guide in most instances, after excluding all torn or bruised tissue, we should plan the line of incision in the third of the extremity above the crush, in order to be certain of getting into sound tissue, or that which will do well.

There is some question regarding the advisability of doing any of the older foot operations, namely, those of Chopart, Pirogoff, or Syme. In the author's experience these have been frequently followed by a tender, deformed stump, to which no satisfactory artificial appliance could be adjusted, and which simply continued to be a detriment and a regret to the possessor (see Fig. 71). There are some cases, however, in which these forms of amputation may be very properly considered.

Never amputate through a joint. To leave any part

of a natural joint precludes the possibility of an artificial one being applied, and, in addition, the cartilaginous surfaces are very prone to slow death, giving subsequent trouble.

Then, too, it is advisable to avoid a hip-joint amputation by reason of its formidable character and resulting

FIG. 71.—Stump Resulting from a Chopart Amputation.

high mortality. The risk of a sloughing stump is probably less vital than a primary hip-joint amputation in cases in which the crush is so high in the thigh as to call for such under the above rules. The shock accompanying the injury is usually too severe to permit of the justifiability of the operation.

Then aside from these special cases, it may be assumed that in a crush of a foot or ankle, the point of selection would be the lower third of the leg; for a crush of the lower third of the leg, make a line in the upper third; for injuries involving the tissues by crush or tear into the upper third of the leg, go just above the condyles of the femur; for a crush of the knee-joint, amputate in the middle third of the thigh.

In injuries of the upper extremity the same rules hold good, save in the hand, which is seldom a fast-train injury. If so, it is well to set aside the rule as far as possible in efforts to save all we can, even if subsequent reamputation has to be made.

A study of the attachments of muscles, and their relation to the line of injury, will assist greatly in deciding what is best toward the future usefulness of the injured limb.

Slow-Train Crushes.

The effects of a slow-train crush may be compared to squeezing the life out of the distal part. The bumper class of slow-train injuries are by far more frequently seen in the hand and upper extremities, and here the benefits of conservatism are allowed more free play by reason of the nature of the cause. The tissues of the proximal part, up to the very margin of the lesion, are found to be capable of restoration, and therefore the line of operation need go no farther. Shreds of torn skin, if still attached to the proximal part, are viable, and can be utilized in covering denuded portions, so that every inch that can possibly be saved can be included.

As we have before noted, the question of conservatism *versus* ultra-conservatism comes more into play here than in the fast-train injuries. In the latter there is no question about amputation being necessary above the ragged end of the injury; but in slow-train injuries, with the knowledge of the fact that we have at once the greater opportunity to save, the temptation to do so frequently serves to overbalance good judgment and foresight in the case, to the subsequent regret of not having been more radical. It is best to avoid having a useless, unsightly part which when once healed over is seldom parted with by the possessor through lack of courage.

With the associated dangers of sepsis, sloughing, and subsequent devitalization of the individual, the choice of error in removing a little too much should be the one accepted, to the attainment of speedier, healthier, and more satisfactory results.

The How to Amputate.

Having been convinced of the necessity for an amputation in cases in which a distal part of an extremity has been injured beyond a reasonable possibility of saving it, having concluded that a primary amputation, or one done within six to ten hours of the receipt of such injury, is the better one to do; and having learned that the nature of the case, coupled with the existing conditions, leads to the line of amputation, it only remains to consider the method of doing such operation, and adopt the best one in treating the injury.

As before noted, it is necessary to have some fixed idea relative to the handling of this matter, and then by modi-

fication appropriately adjust it to each and every case coming to us; for we will find, especially in one class of these railway injuries, the necessity for so doing.

First and always in any contemplated amputation an anæsthetic must be given, and usually it is better to do so before beginning to clean up the parts, as this then can be more thoroughly accomplished. We have advised before

FIG. 72.—Showing the Proper Method of Applying an Esmarch Bandage previous to an Amputation.

to use the anæsthetic one is accustomed to use; and it is unnecessary to reiterate the particular care with which the cleansing process should be carried out, by shaving, soaping, scrubbing, and disinfecting in and around the entire region where the injury and proposed operation is located. An Esmarch bandage should be applied, if not already on, and should be placed high enough to give plenty of room for the proposed field of work.

The proper application of this bandage is to be noted (see Fig. 72). Pass several turns of a three-inch rubber

bandage tightly around the extremity, and do not permit the bandage you use to roll up or fold into a narrow cord, which is liable to make so sharp a compression upon the vessels as to injure their coats, and possibly cut them off permanently.

After protecting all the neighboring parts by clean or sterilized coverings, the question of flap presents itself. Referring back to the kind of injury to be dealt with, we find that if the injury was caused by a slow train, operations can follow close to, and include, if need be, torn shreds of skin to cover bare parts, in order to make a stump. Here, then, do not be confined to any flap at all. Trim off the ragged edges, cut away shreds of skin not wanted, chip off the ends or heads of bones that are protruding, cut off the ends of tendons and nerves, and patch the remaining skin over the end.

The special indications in injuries of the hand, and how such should be met in that region, have been fully noted.

If through the body of an extremity, flaps must be taken from the proximal part, always discarding bruised or blackened skin, and going back until an incision can be carried into viable tissue.

In fast-train injuries, or in any variety where by reason of the actual traumatism, or on conservative grounds, amputation is to be made above the margins of the wound into fresh, healthy tissue, an ideal amputation should be done, choosing that method which will be the best for the case, and doing it as any primary operation should be done, with every care and intent of its being followed by first-intention union and a solid stump.

Always taking time to have every detail arranged for the purpose of doing this, the form of flaps to make pre-

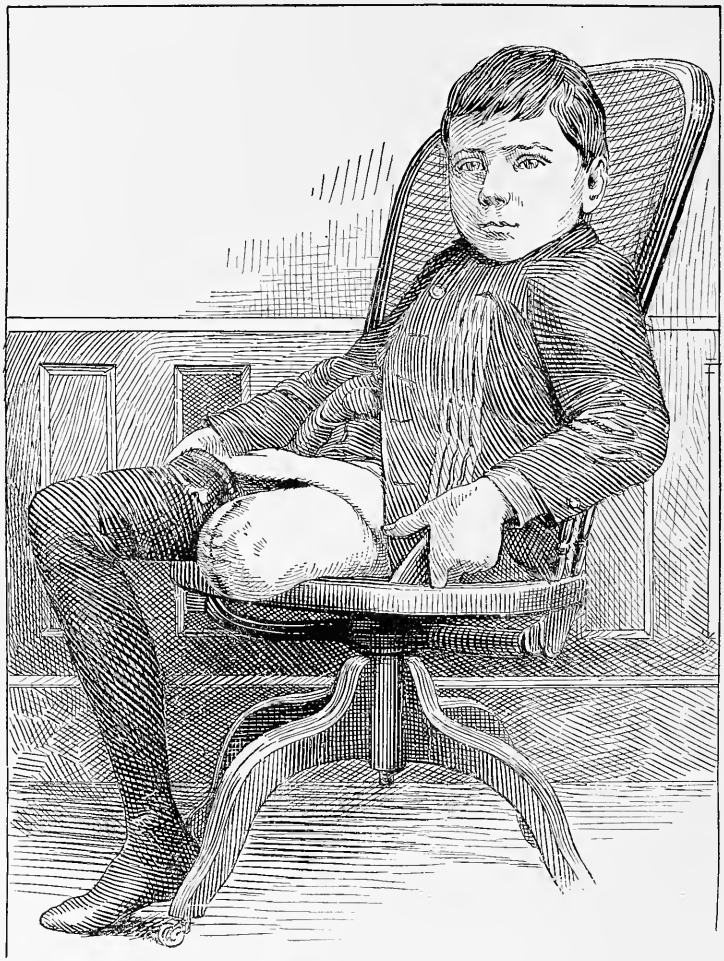

FIG. 73.—Stump Resulting from the Side-flap Method.

sents itself. It may be found that on account of the relations of the tissue at your disposal, it will be wise to choose a side-flap operation, which presents a very good

appearance, as shown in Fig. 73, or it may be that a Teal's method with a long anterior and short posterior flap can

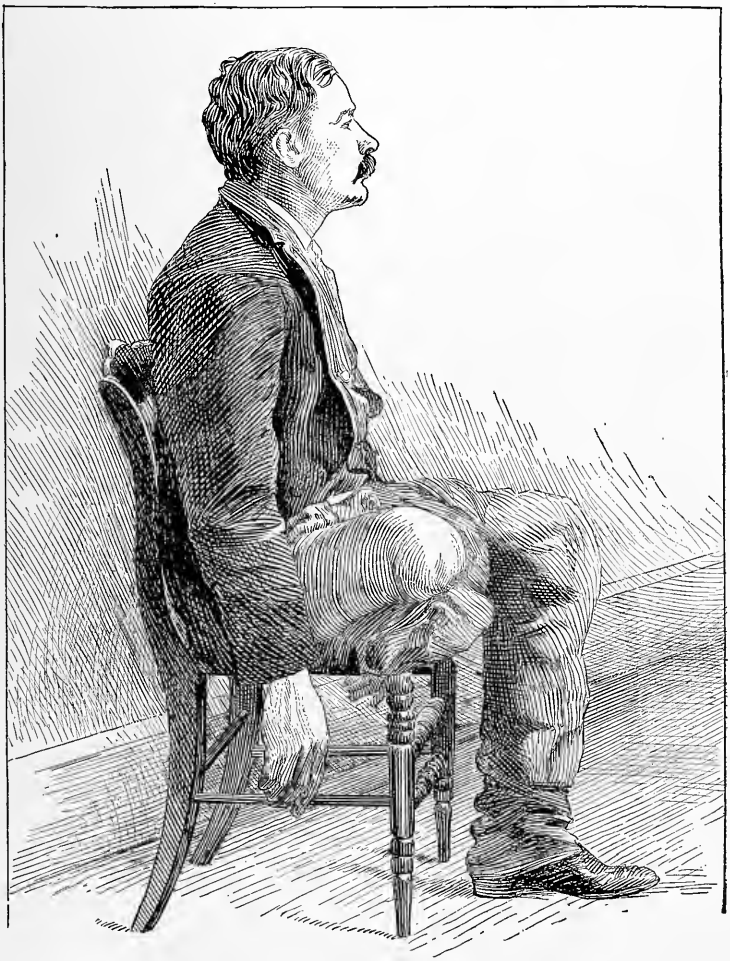

FIG. 74.—Resulting Stump after the Teal Method.

be used to the best advantage, resulting in a very comfortable stump (see Fig. 74). In the shoulder-joint operations the oval flap (see Fig. 75) gives the best result,

and one least likely to become unhealthy. The circular method is probably the most rapidly performed, and it

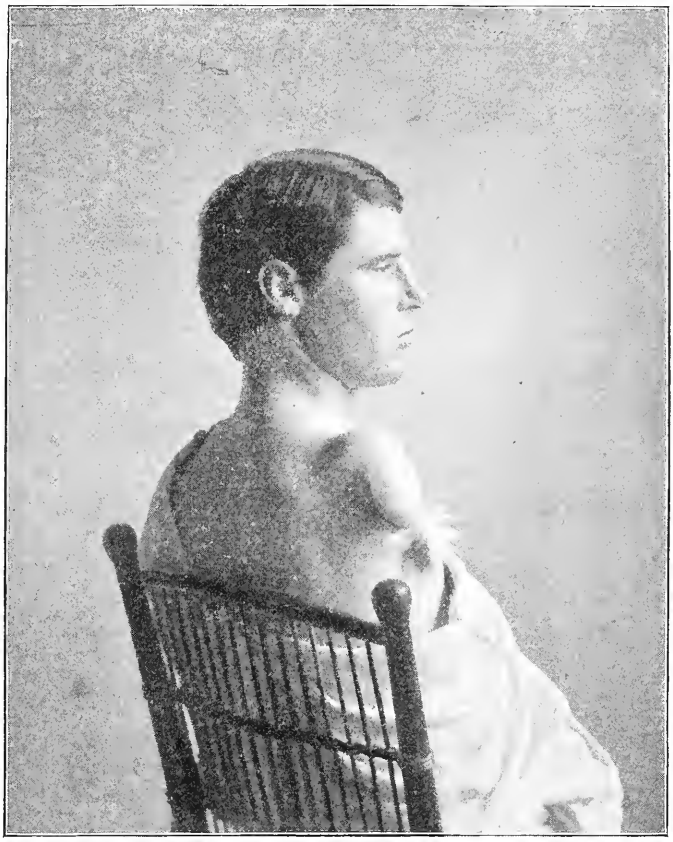

FIG. 75.—Shoulder-joint Amputation. Result from oval-flap method.

is usually the best to do, inasmuch as it requires less flap than others.

The manner of doing this is as follows: Everything being ready, a long knife is swept around the extremity at the point selected, carrying the incision down to the muscles. A cuff is now turned back to a distance sufficient

to give a covering for the end of the stump (see Frontispiece). Just how far this should be turned back is a matter of some judgment, and depends upon the elasticity of the skin and the size of the limb. The younger the individual the more elastic the skin, and as the incision is made, the degree of retraction noticed therein will be a guide in this matter. After enough cuff is obtained a circular incision is again carried at right angles down to the bone, dividing everything. In the forearm or leg a narrow knife is passed between the bones to divide the structures between them. A stout retractor of gauze or muslin is now placed to hold back and protect the proximal tissues, when the saw is engaged upon the bone and this divided. Have an assistant hold the distal part firmly all this time, and saw the bone steadily. In the leg or forearm engage both bones at once and complete the section of the small one first.

After removing the retractors the bone forceps can be used to bite off slight projecting edges of bone, and next the arteries should be sought for. Silk should be the choice in ligating the large vessels; well hardened catgut may do for the minor branches. Ligatures should be applied systematically and thoroughly. Very hot water poured over the stump will control the muscular oozing, after which the Esmarch can be loosened gradually, watching carefully for the appearance of spurting vessels, these being caught up by hæmostatic forceps as they show. Firm pressure with dry gauze pads for a few moments will greatly assist in checking the oozing.

The final result in the circular method of amputation is seen in Fig. 76.

As to sutures, if a high operation is done in sound tis-

sue, close the flaps, using deeply placed silkworm-gut sutures and a few superficial ones where the skin gapes, apposing skin to skin throughout the entire line.

FIG. 76.—Result in Amputation by Circular Method.

If operating on the slow-train group of injuries, and amputation is done close to a margin of damaged structure, it is better to leave the stump entirely open, or apply but a

few supporting sutures, and drain the same freely with gauze or tubing.

A large absorbent dressing of plain sterile gauze, well supported with bandages, should now be applied, and a splint over all to give support. This latter should include the joint contiguous to the line of amputation. A crinoline bandage serves to secure the entire dressing against becoming loose.

Double Crushes.

Where the necessity calls for the performance of more than one amputation, methods may be adopted as in any single operation. The amputation which is called for at the higher point should be done first, although the cleaning-up processes should be completed upon both extremities before any operation, then the one to be done last should be protected by plenty of sterile coverings. When an upper and a lower extremity figure in the case, and the opportunity presents itself, two operators may better work at the same time, each performing one amputation. Cases will rarely occur in which both amputations cannot be finished at the same time (see Figs. 77 and 78).

Subsequent Care of Amputation Cases.

As to the subsequent care of these cases, we must depend upon the kind of injury we have to deal with. If a high amputation has been done through sound tissues, the dressing may remain a week or more, unless the temperature shows that trouble is ensuing, or a discharge makes

its way through the dressing. These are invariably the signs for a redressing in any case. If the amputation has been done near the line of injury, or in cases in which doubt-

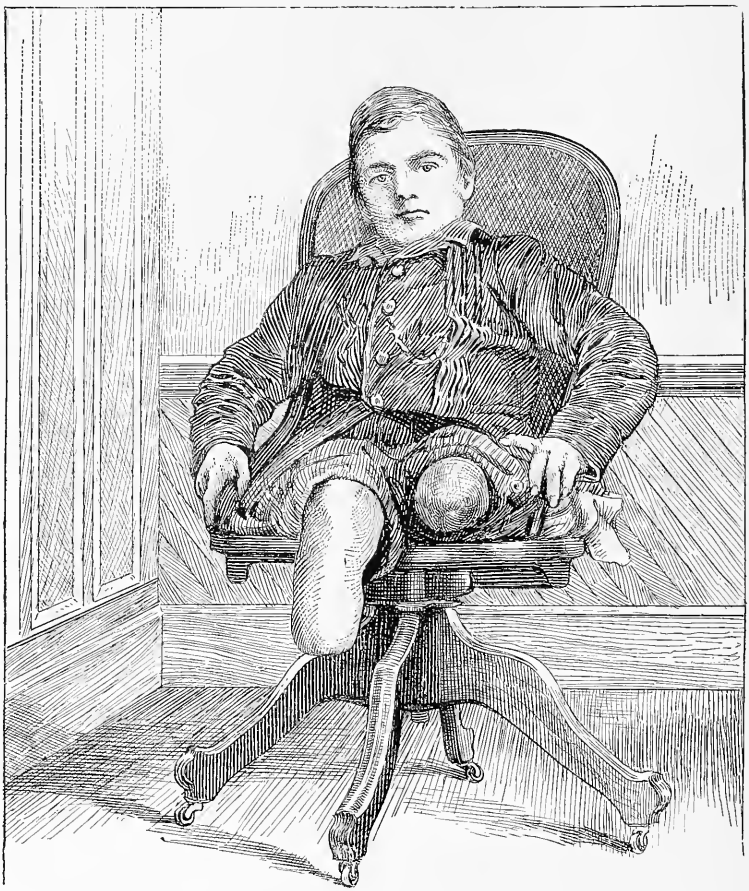

FIG. 77.—Double Amputation (synchronous).

ful tissue has been included in the parts retained, daily dressings should be the constant rule. In all redressings the greatest care should be given to all the aseptic details, and these carried out as in the primary instance. The

drain, if left in, can be permanently removed when the appearances show that its retention is no longer necessary. In case of an open stump, use plenty of douching

FIG. 78.—Appearance of an Unhealthy Stump (ulceration of the right).

with a 1:1,000 or 1:2,000 bichloride solution, and occasionally the dioxide of hydrogen may be employed. As granulations begin, support should be given the flap by snug bandaging, and straps of gauze bound about the stump. Where sutures are employed, they can be removed in from four to six days, and if much tension is upon them, it is better to remove every alternate stitch at the first redressing, and the remainder a day or two later. At any sign of a stitch-hole abscess, the infected suture and those contiguous should be removed at once, and the tract washed out.

As a rule, good results, with primary union, may be expected in from two to four weeks; in wounds closing by granulation in from six to eight weeks.

Special Points.

Now as to special points in certain amputations we would call attention to a few. In removing or trimming torn fingers, hands, or toes, it will not be necessary to use ligatures at all on the vessels. Leave the Esmarch bandage *in situ* until a particularly snug dressing has been applied to the extremity, when on removing the Esmarch there will be no signs of hemorrhage sufficient to need control. This saves much time and is very desirable.

All these trimming-up operations, especially if it be a hand or foot, require no more instruments than an Esmarch bandage, scissors, bone forceps, and dissecting forceps, possibly a needle and some silk for a few supporting sutures.

In regard to a hip-joint amputation, if called upon to

do such, it is wise to adopt the procedure first advised and performed by the author, of making the preliminary step of ligating the femoral artery as it emerges from the pelvis; and since this controls the principal blood supply to the parts, there need be no fear, as the greatest danger in the operation is set aside, and there are no subsequent untoward effects from this method of doing a hip-joint amputation.

There are some conditions met with after amputations that are worthy of note. Among these may be mentioned unhealed stumps, or those which have healed to the suture line, which continue unhealthy and are attended with some discharge (see Fig. 78). The cause of these conditions is usually a necrosis in the end of the bone, and should be treated by a thorough curetting through the sinuous tract, and packing the latter with gauze, to force it to heal from the bottom. At times it becomes necessary to open up a stump and saw a section from the bone in order to get a permanent healing.

Again, a sinuous tract may lead to a ligature which has been infected, and is trying to work its way out. If this is suspected it must be located, removed, and the tract curetted, washed out, and packed.

There is a condition of painful or irritable stump, at times seen either soon after complete healing or some time later. If a tender point is made out close to the cicatricial line, it is probable that a nerve end is attached and irritated. Here a subcutaneous section of the same can be done, and the tissues under the cicatrix loosened up. If the point is higher up, and away from the cicatrix, it may be felt as a distinct kernel, causing pain on pressure.

Here there is probably a small neuroma, and an incision and removal of the same become simple and necessary things to do, relieving the pain at once.

The muscles of a stump always atrophy as time ad-

FIG. 79.—A Well-Formed Stump (the tapering appearance).

vances, so that the latter assumes a tapering appearance, and if properly healed should be absolutely painless and

capable of supporting pressure (see Figs. 79 and 80). At this time it is proper to apply an artificial apparatus.

FIG. 80.—A Good Resulting Stump (the tapering appearance).

At any earlier period the new tissue will be very apt to break down from the pressure and irritation of the apparatus.

CHAPTER XVII.

INTERNAL INJURIES.

Causes.

INTERNAL injuries are not at all rare in the practice of the railway surgeon, inasmuch as the liability to blows, falls, and squeezes is so great in the discharge of their duties by the yard or train workmen, and the forces causing such are so powerful. The thoracic and abdominal organs are not wholly protected by bone, and slight blows are sometimes followed by an injury to one of their contained viscera. Such lesions are also very frequently met with as complications of injuries to the extremities and to the skull.

Degree and Severity.

The degree and severity of any lesion of an internal organ to a great extent depend upon, and follow the degree of force acting as a cause; but this is not always the case. Slight force may contuse or even rupture a viscus, while frequently a very severe fall or blow may happen to an individual without being followed by any disturbance whatever of the organs. Many times an external wound is produced in the chest or abdominal wall, the force continuing down to and implicating the underlying viscera, or a fracture of the rib or pelvis may be really the cause

of trouble, through the sharp edges of the broken bone damaging the structures beneath.

Among the internal organs some are solid, and others are hollow. The lesions that may occur to these organs may be contusions, lacerations, or complete crushing.

In a contusion of a solid organ there would be some slight outpouring of blood into the structure, owing to the rupture of capillary vessels, while in a hollow organ a contusion would necessarily be confined to its superficial or outer coverings.

In a laceration of a solid body the tear might, or might not, extend to the outer surface, and upon this circumstance the outcome of the case may rest; for confined within the capsule or outer covering, the hemorrhage, which would necessarily ensue, would be controlled by the simple resistance of the uninjured structure of the organ, while if the rent reaches the surface the blood could flow freely into the containing cavity, and thus lead possibly to a fatal result.

In a hollow organ a laceration may penetrate only the coverings, but usually means a complete rent through all its walls, which not only permits blood to flow out freely, but also permits the escape of whatever contents were in the organ at the time of rupture.

A complete crushing of an organ occurs only with very extensive and severe injuries, but inasmuch as these cases invariably terminate fatally at once, or within a very few hours, they need not be considered any further.

Signs, Symptoms, and Diagnosis.

The symptoms in general produced by injury to an internal organ are pain, vomiting, short breathing, and shock. Pain cannot always be considered as a very definite sign, inasmuch as badly injured persons with intense shock are usually unconscious, and therefore the presence of pain cannot be localized; and even if they are conscious, it is not at all times definite enough to localize. Frequently, however, if demonstrable, it will be found to be persistent and fixed, radiating from one point, which may be found to be located directly beneath some external marking, more or less distinct.

Vomiting is not always seen, and although it frequently marks the advent of shock from any cause, it is only when it is mixed with blood, and is persistent, that it becomes a suspicious symptom.

Short and rapid respiration noticed in the conscious state is a particularly valuable sign of internal lesion, and is due to the efforts on the part of the individual to restrain the movements of the organs during the respiratory act, in order to give relief to the pain or distress caused by them.

Shock is always present, but inasmuch as it is also constant in any serious injury, it must be traced to the internal lesion by reason of the absence of other visible injury of severity, or the markings or history of injury to the locality. It might be present in a simple blow upon the abdomen without any lesion whatever, but would not be severe, nor accompanied by any grave symptoms, the patient rallying rapidly and completely in an hour or two.

If profound or persistent, it denotes deeper injury, and as hemorrhage has much to do with the causation and continuance of shock, so the outpouring of blood resulting from a severe laceration of an internal organ will bleach the skin very rapidly, and be accompanied by stupor, shallow, slow, and irregular breathing, with occasional sighing, great prostration, and cold clammy skin, with great beads of perspiration on the face.

While individuals with such severe symptoms would usually be unconscious, yet they are at times found in the full possession of their faculties, as noted in a case coming under the observation of the author. A man was run into, while lying prostrate across a railway track, by the truck of a loaded car either riding up on to his abdomen or crowding him along the rail, to a sufficient degree to mark the external skin by a line of abrasions extending irregularly over the middle of the abdomen, and oppositely, across the lumbar region. Though perfectly conscious, complaining of unquenchable thirst but no pain, he presented all the other symptoms of intense shock. As he was *in extremis*, no operative measures were considered, and death followed after six hours.

As an illustration of the irregularity of conditions, and as evidence of how much damage can be done beneath an unpunctured skin, it was found upon autopsy, in this case, that a segment of the ileum, some eighteen inches in length, was completely severed from all its attachments and continuity.

Cases may be met with in which, through the presence of an external wound leading down to the structures below, a direct inspection of the condition of such organ may be

made, or a portion of the viscera may even be protruding through the external opening, thus giving direct evidence of its condition. If such an external wound is penetrating without a doubt, and through the nature of things an injury to an organ beneath is suspected, it is right and eminently proper to enlarge the opening, if it is small, to a sufficient size to enable the surgeon to acquire a positive knowledge of the lesion. In the same procedure the damage could be repaired, if such were demanded.

Treatment.

The general treatment to be given when an internal injury has been inflicted and the above-mentioned symptoms are present, must be along the lines of combating the shock, followed by a repair, if possible, of the damage done. If the patient is conscious, anodynes hypodermically administered are imperative as soon as the location of the injury is ascertained for the purpose of determining its severity.

The usual remedies and means for allaying the shock are noted in the chapter devoted to that subject. Warmth, stimulants, restoratives, and saline transfusions should be freely administered, combined with absolute rest and quietude, the individual not being moved one foot farther than the nearest shelter where warmth can be obtained. If localization of the injury is possible, an ice bag over the parts is useful until further treatment is devised. If an external wound is present, it should be carefully attended to in the manner indicated for such a lesion, and if an extrusion of contents is present, the organ or organs should be carefully inspected, cleansed, warmed, and returned.

The wound should be drained to a greater or less extent according to its severity, the probability of sepsis having entered into the case.

If the presence of this external wound renders it possible to ascertain the condition of the organ below, it should be cared for at once, painstakingly. Any rent in its surface should be repaired by suture, and all blood clots in the locality cleaned out.

If this condition coexists with other injuries, all should be attended to, attention being first given to the general condition, and such influences as hemorrhage and exposure, potent causes in devitalizing the condition of an individual, allayed.

Prognosis.

The prognosis in internal injury is extremely grave, and many patients succumb in a few hours, depending of course on the severity of the lesion and the importance of the organ injured.

Contusions are usually recovered from if inflammatory conditions do not supervene and cause abscess in the solid, or complete perforation in the hollow organs. These states manifest themselves subsequently.

The prognosis of lacerations depends upon the hemorrhage and escape of material into the free cavity. If they are not severe, or the rent is quickly repaired, patients frequently recover. Other complications usually present, however, turn the case into a fatal channel very rapidly.

Thus it is seen that even when the case has presumably been one of contusion only, subsequent changes may occur to terminate it unfavorably; as by the supervention

of such conditions as perforation or abscess requiring the performance of a surgical operation, which, added to the existing state, acts as a fatal circumstance. The prognosis, therefore, should be extremely guarded.

Special Considerations.

There are certain symptoms referable to the several organs confined within the domains of the thorax, abdomen, and pelvis which should be separately considered, both as to their diagnostic value and the treatment to be given them. The prognosis also depends largely upon the organ so injured.

Lungs.

In the lungs a lesion is seldom produced through other means than fracture of a rib, the jagged end of which punctures through the pleura and into the pulmonary structure. Such an injury is followed at once by an escape of blood and air into the pleural cavity, of blood into the bronchioles, and possibly of air into the cellular tissues over the ribs.

Shock is seldom present to any degree, and with consciousness prevailing, the patient makes known the locality of the injury by the pain, which is accompanied by short catchy respiration, and some expectoration of bloody froth.

If the laceration is extensive, the hemorrhage may be sufficient to drown the individual in his own blood, and result fatally at once.

The majority of cases seen, however, present less se-

vere symptoms, and beyond a localized pleuritis or pneumonitis, quickly subsiding, there is little to note. Emphysema in the cellular tissue is denoted by a crackling sensation imparted to the palpating fingers over the swelling produced by it. Some pyrexia, pain, and rapid respiration mark the advent of inflammatory symptoms in the pleura or pulmonary structure.

Prognosis.

The prognosis is not grave after the first dangers of hemorrhage have passed by, the patients usually doing well under wise treatment.

Treatment.

The treatment of such a condition would be principally symptomatic, in addition to the relief of pain by hypodermics of morphia and the application of a fixed dressing around the chest. An ice bag may be applied if hæmoptysis is severe, and antipyretics given to combat the febrile symptoms.

LIVER.

The liver by reason of its weight and solid nature may be injured through *contrecoup* alone, and also by direct violence sustained over its region, as well as through puncture of a fractured rib making its way through the diaphragm and into the structure of the liver.

Symptoms.

The special symptoms to be noted in laceration of this organ, aside from the evidence directly associated with it in

the way of an external wound, are extreme shock, due to the outpouring of blood and bile into the peritoneal cavity. Local pain, if the patient is conscious, is present, and also pain in the region of the shoulder blades. A simple concussion with slight contusion may not give rise to any serious symptoms beyond the first slight shock.

Treatment.

As to treatment, an ice bag applied locally and anodynes are all that can be done, unless through an external wound, accompanied by an increase in signs of internal hemorrhage and other conditions, or by a careful exclusion diagnosis, a rupture through the periphery of the organ is made out. In that case an incision over the liver, and cleaning out of blood clots, with suture of the rent in the structure, may be considered proper.

Prognosis.

The prognosis in cases of severe rupture is grave, and usually the patient succumbs to the condition before any operative steps can be taken.

Stomach and Intestines.

In the stomach and intestines we have hollow organs to deal with. Much depends on their condition of distention with contents, as to probable rupture when the impinging body acts upon them. If full, a rupture much more easily occurs, and the contents of the organs escape more freely. When empty and flaccid, rupture is not likely to occur, and contusion only would ensue.

Symptoms.

In contusion, the symptoms will be nothing more than localized pain and probably vomiting, with some slight shock. When laceration has occurred, not only will the contents of the stomach be ejected, together with fluid and black blood, but some of the same mixture will immediately escape into the peritoneal cavity, largely increasing the gravity of the case. If a small rent did occur during flaccidity, its margins would have a tendency to keep together, which, with the rapid healing of peritoneal wounds, might possibly very soon result in an impervious closure.

In the severe condition, shock will be more profound, which, with the black vomit, localized pain, the history, and external markings, if any, will lead to a diagnosis.

In case of rupture of the intestinal tract, an additional valuable sign may be found in the escape of gas, which wlil distend the abdomen, and marked tympanites will be present, even over the liver where no intestines are to be found.

A slight hæmatemesis does not necessarily indicate severe lesion of the stomach, as this may occur after a blow without any destruction of tissue, through rapid congestion, with enough oozing of blood from such an area to color the vomited material. Absence of severe symptoms, and rapid rallying, will serve to indicate the slight nature of the trouble.

Treatment.

In the treatment of perforating injuries of the stomach or intestines, there is but one procedure likely to be of benefit, and that is an immediate exposure of the organ through a laparotomy and a repair of the rent, with a thorough douching out of the cavity of the peritoneum with hot decinormal salt solution.

The proximity of a meal may be taken as a guide to the absolute necessity of immediate operation; otherwise, a delay long enough to permit the patient to rally somewhat from the primary shock would improve the prospects of the case. If it could be ascertained that, as far as the contents of the stomach are concerned, there was little to be feared, the operation could then be delayed, unless conditions denoting the continuance of hemorrhage were on the increase.

Prognosis.

The prognosis depends upon the fact whether or not the gastric or intestinal contents have escaped into the peritoneal cavity, and upon the severity of the hemorrhage; it will also be governed somewhat by the resistance offered by the patient's general system to the resulting toxæmia.

SPLEEN.

The spleen may be injured, like the liver, either through direct violence, or by the fractured end of a rib.

Diagnosis.

Nothing beyond localization, either through pain or an external wound, can assist in the diagnosis. Other symp-

toms may be general, and if the lesion is severe, death will soon ensue through hemorrhage alone.

Treatment and Prognosis.

Indications for treatment, as well as the prognosis, follow the same lines as in the case of an injury to the liver.

Urinary Tract.

Injuries to the urinary tract are important, as they are not infrequently seen both as a result of direct violence and of indirect origin, as from a fractured bone.

When such injury causes a rent deep enough to open the cavities of the organs in this tract, there is an immediate escape of urine, which has a particularly disastrous effect upon the tissues, as it soon decomposes and not only gives rise to abscesses but permits the absorption of urea.

Symptoms.

Simple contusions anywhere in this tract are not followed by any special symptoms, and will be along the usual lines found to pertain to other organs.

Any laceration of the tract with escape of urine is followed by general symptoms associated with a diminution in the amount of urine voided, or possible for the patient to void, hæmaturia, and local pain referable at times to the groin. Shock is usually not severe in these cases. Any injury which from the history or external indications can be traced to this tract should be at once investigated, and the amount of urine present in the bladder, together with the history of its last evacuation, be carefully noted.

In addition to these symptoms and signs, an intraperitoneal rupture of the kidneys or bladder will soon be marked by peritonitis.

Extraperitoneal rupture of the kidneys will permit the urine to escape in the lumbar region (see Fig. 81, *PP*), in which position it will soon make itself prominent by a fluctuating swelling, or later by pain, chills, and rise of temperature.

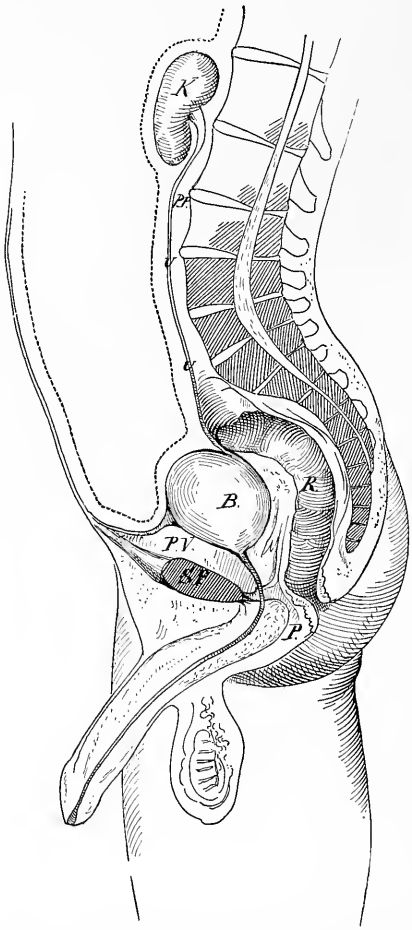

FIG. 81.—Schematic Representation of the Relation of the Genito-urinary System to the Peritoneal Cavity. Dotted line represents the peritoneum. *K*, Kidney; *U U*, ureter; *B*, bladder; *S P*, symphysis pubis; *R*, rectum; *P P*, post-peritoneal space; *P V*, prevesical space; *P*, perineum.

Treatment.

When the latter condition presents itself the treatment should be an immediate incision over the swelling, and if urine is found, it should be freely washed out and drainage instituted, the latter carried down to the structure of the kidney. Such a packing should be given the wound as will cause it to heal from the bottom, or the rent in the organ should be closed by suture.

If the conditions point to an intraperitoneal rupture, an incision must be made through the abdominal wall and the rent closed.

Bladder.

The bladder is more liable to be ruptured if full of urine at the time the accident occurs. If injured extraperitoneally, the escaping urine may find its way into the prevesical space, filling that, and appearing as a swelling in the cellular tissue of the groin and abdomen (see Fig. 81, *PV*). Or if the rent is perineal, this region will soon show the presence of the extravasated urine by swelling in that locality, even extending down upon the thighs (see Fig. 81, *P*). When such a condition as injury to the bladder is suspected, no matter how slight, the fact whether a rupture exists or not should be at once ascertained.

Determine, if possible, when the person last urinated; pass a catheter into the bladder and note the amount withdrawn. If the urine has not been voluntarily voided for some hours previous to the injury and none is obtained by catheterization, the fact of rupture is quite certain. To verify this, pass through the catheter a known quantity, say six ounces, of warm decinormal salt solution or sterilized water, and withdraw it after a few moments, noting any difference in the quantity thus obtained. This will not only decide the question as to whether a rent is present, but will also indicate its location; for if after such injection the swelling in the perineum or in the suprapubic space increases, there lies the seat of rupture. If no fluid returns through the catheter, and no swelling appears in

the above-noted regions, then, by exclusion, we can safely decide that an intraperitoneal rupture is present.

There is one thing to be guarded against in this proceeding, and that is a stoppage of the eye of the catheter by a small clot of blood that may be present in the bladder, and thus give the impression that the fluid injected has in part or entirely escaped otherwise. A little care will decide this positively.

In case some injury has been done the urethra so that catheterization cannot be performed, the above procedure can be carried out through a suprapubic puncture of the bladder.

In the case of an intraperitoneal rupture of the bladder, the same rules as are given for a similar condition in the kidney may be carried out.

A suprapubic rupture must be made complete to the outside, and be well washed out and drained. The same method of treatment is to be employed if the rent is found in the perineal region.

After a perineal section, a soft catheter may be passed through the urethra and kept *in situ* until the perineal wound heals over. All cavities formed by the extravasated urine should be kept scrupulously clean and well packed with gauze, and the bladder irrigated daily with salt or boric-acid solution.

Conclusions.

In concluding this chapter, it should be remarked that while the above notes of treatment are given on the assumption that only a single lesion exists, it must be remembered, as so often remarked in this work, that through

the powerful forces at play these injuries are very frequently, and we may say almost constantly, complicated with other lesions of a severe character, so that the coexistence of such serious injuries nearly always prevents the accomplishment of anything more than temporary relief during the few hours that the individual so injured survives. Yet in view of the fact that there are exceptions to all classes of cases, and as it is possible that such exceptions may come within the experience of many engaged in this practice, these rules for treatment and consideration are given, in order that if the necessity arises and opportunities for more than ordinary relief offer, treatment be given in the most approved and scientific manner.

CHAPTER XVIII.

INJURY OF THE SPINAL CORD.

Anatomy.

In order properly to consider the various spinal-cord lesions, it is imperative to study the position of the cord and its relations with its coverings, as well as to review the make-up of the latter, and the anatomy of the spine as a whole.

The cord lies in a canal extending the entire length of the spinal column, formed by a juxtaposition of the vertebræ making up the backbone. These vertebræ, to the number of twenty-four, articulate one with the other, and are furthermore separated at the densest part of their formation, the bodies, by layers of cartilage as thick almost as the bodies between which they lie. The bones are held together by interligamentous bands, strengthened by many fibrous fasciculi passing from point to point, and still further strengthened in their positions by large thick bundles of muscles which pass up and down the spine and attach themselves to its processes.

As a whole, the column is very flexible and elastic, and is covered by heavy cushions of softer structures.

The spinal canal is lined throughout by membranes, and encloses the cord, which fits rather loosely at all points and is really suspended in the canal by its continuity

with the brain above, and by the nerve trunks which pass out from it between the several vertebræ.

Besides being of a rather firm structure and not easily injured, it is readily seen that the cord is situated in a very well-protected position, requiring a force of no small degree to penetrate to it.

Causes.

The causes which will give rise to a lesion of the cord with its consequent effects, are those likely to produce either a compression or a laceration of its structure. A laceration, however, is not necessary to demonstrate the serious effects of a lesion, for it is enough that the molecules of the cord or the nerve cells themselves are disintegrated; this may be accomplished without giving any macroscopical evidences of injury to the structure.

Force sufficient to bend the spinal column until one of its processes is fractured, or to produce a separation or dislocation of the vertebræ, so as to permit an impact of the force directly against the cord, must of necessity be followed by injury of the latter. Direct force, on the other hand, by impinging upon the backbone at any point in sufficient degree to produce a fracture of the transverse processes of a vertebra and to drive the segment thus fractured, usually including the spinous process, down upon the cord, will also cause a lesion severe enough to be followed by all the symptoms consequent upon such an injury.

The degree of force necessary thus to fracture or dislocate a vertebra, strongly cushioned and protected as it is, is by no means inconsiderable.

A mere twist or jar given the body, with no more force than is necessary to cause a fall, cannot be causative of such a lesion. Falling from a height and striking a hard object or the ground when the body is in a doubled-up position, or falling across some object so as sharply and forcibly to bend the back, may be followed by either of the conditions noted above. Or, on the other hand, any heavy weight falling and striking an individual upon any point of the spine may by its direct force be followed by a fracture or a dislocation of the vertebræ.

Upon the railway these forces are met with, and they are encountered as causes of this lesion when persons are violently thrown across the tops of seats in a passenger coach in consequence of a collision; or when they are thrown or fall from a car in motion and strike against some structure with sufficient violence to double up the body; or when cars are derailed, topple over, and throw the passengers violently and promiscuously about the inside of the car.

The external signs pointing to the existence of a spinal lesion are discolorations and ecchymoses over the site of the injury, and an irregularity in the spinous processes. On palpation, crepitation may be discovered.

If the processes be cut down upon they may be found driven directly into the cord, or simply fractured and pressing somewhat upon the cord, or the fragments, although somewhat displaced, may be found not to be pressing at all upon this structure. The cord may be found surrounded with blood clots. In case the cord is found impinged upon, a laceration or a depression upon its surface or into its structure may be discovered at the site of such pressure,

although many cases are seen in which there is no appearance whatever of material damage. It seems as if by the flexion of the column, or by the force which has acted upon, fractured, or dislocated it, a squeeze of the cord has been accomplished which, while not leaving any mark behind, yet has by such pressure, at the moment of impact, inflicted permanent damage, even though the fragment so impinging is at once relieved from its displacement by a return of the column to its normal position.

Simple hemorrhage into the envelope of the cord or its canal cannot produce any positive permanent damaging effects upon its function, unless the effusion of blood is accompanied by injury from bone pressure, as above noted. The structure of the cord is rather firm, and therefore will resist a blood clot, which will under pressure take the direction of the least resistance, that is, along the line of the canal.

The hemorrhage in these cases not being very severe, and in fact but an oozing from very small branches, it is arrested as soon as slight resistance is encountered. Upon opening the canal in these cases it is rare to find the hemorrhage in evidence beyond a small area above and below the site of actual injury.

The author has observed cases in which, upon operation, fragments of fractured bone have been found displaced without any evidences of hemorrhage beyond a slight accumulation between the fragments, the spinal canal and structure being entirely free. Yet the symptoms present in the cases proved unmistakably that the cord was absolutely destroyed. In one such case, upon viewing the anterior surface of the cord opposite the site of a fracture

of the transverse and spinous processes,t here were an ecchymosis and appearance of a flattening of the surface of the cord, apparently caused by the pressure of the body of the vertebra at the moment of forcible forward flexion of the body, as happened in this case.

An excessive hemorrhage caused by extensive laceration of the structures surrounding the cord may occur without actual destruction of the latter, the symptoms not occurring at once, but supervening gradually after the accident, and being not of a positive but rather of a subdued degree.

The theory that concussion of the spine with consequent injury to its cord can occur is an untenable one. Protected and suspended as it is, surrounded by layers of soft membranes, and nearly always by a "water-bed" in the nature of the cerebro-spinal fluid that fills the canal, there is no possibility that a mere shaking up or indirect force applied to the column, unassociated or uncomplicated with fracture or dislocation, will produce a material injury to this structure, or in any wise interfere with any of its functions. The cases that are reported as such, because symptoms referable to spinal-cord injury were complained of without any bone lesion being demonstrable by physical diagnosis, are in all probability instances of sprain of the muscles of the back, hysterical or psychic affections, in no wise comparable to a true lesion of the cord.

Hemorrhage into the cord or its envelopes is also incapable of producing subsequent symptoms of a true lesion, inasmuch, as before noted, a mild pressure only can be exerted by it, enough possibly to cause a blunting of some of the sensory or motor functions of the

cord, but not sufficient to produce the full symptoms of laceration.

The cord can be injured to the degree of permanent disability, and this injury be followed by the train of symptoms caused by such destruction, only by being actually impinged upon by the bony structures around it, or by being penetrated by some body which is more dense than the cord itself. A dislocation or a fracture of a vertebra with a consequent pressure upon the organ, therefore, is the manner by which lesions occur. A few cases of stab or bullet wounds penetrating the spinal canal and doing damage to its contents are recorded, but this is outside the domain of our special consideration.

Signs and Symptoms.

What, then, are the symptoms and signs of a true cord lesion?

They may be summed up in the one word, paralysis. The immediate symptom, when a person has suffered an injury to the spinal cord, is a total inability to help himself from the moment of being so injured. Some pain will be complained of, referable to the back, which is also tender to the touch. External wounds are not the rule, unless the violence has been exerted in a direct manner upon the back, which would then present a bruised and ecchymotic appearance. Some shock will also be present. If the injury has been in the cervical region, there will be stiffness or inability to move the head without causing much pain, and there may also be some difficulty in breathing, due to the paralysis of the intercostal muscles.

Upon closer examination it will be found that there is an absolute paralysis of both motion and all kinds of sensation below the point of injury, together with complete retention of the urine. It may be possible that, owing to the shock or the presence of coexisting injuries to the head or other complicating condition, the individual may be in an unconscious state, wherefore it will not be possible to determine at once the true condition of the paralysis present. Whether the latter is due to the injury to the back, or to the head injury if the latter is present, can be determined by localization after consciousness is restored.

The symptoms that might ensue as a result of a hemorrhage into the canal sufficient in degree to interfere with the functions of the cord, are those of a gradual numbness in the extremities and some interference with their motion. These symptoms do not go on to a complete paralysis, but after a few days begin to recede and power is restored.

Great care is necessary to differentiate this latter condition from psychic paralysis and conditions depending upon the neuropathic state of an individual, inasmuch as the shock and circumstances surrounding the accident, coupled with the pain and soreness consequent upon a sprain or bruise of the back, will so confuse matters as to render it very difficult to distinguish between them. If any time elapses after the accident before the surgeon sees the case, especially if the patient is predisposed to neurasthenia, this element will be much more pronounced, until he verily believes that a paralysis exists, and this condition will require all the skill and diplomacy of the surgeon to elucidate.

Diagnosis.

One thing is certain, that paralysis ensuing as a result of actual injury to the cord comes on at once before the psychic element has an opportunity to figure in the case, and is as well a permanent feature. As time advances, the persistence of the symptoms and the certainty of conditions beyond the will of the individual mark the case as a genuine one.

In the latter group are the states of retention, or atony of the bladder, and paralysis of the bowels. Cystitis is very prone to follow spinal-cord injury and may be looked upon as a very strong diagnostic point. Purulent neprhitis follows this as a matter of course. As the condition of helplessness continues, bedsores and other evidences of an impoverished condition of nutrition will become prominent. Atrophy of the muscles in the affected region will also occur, while the sensations and motions are absent, although the reflexes may remain for a considerable time, brought into evidence by the ordinary tests and by the use of electricity.

When the cord is affected in the cervical region the diaphragmatic breathing, the presence of the girdle sensation, and extension of sensory and motor loss to the upper extremities will be noticed. If these symptoms are urgent, there rarely remains much necessity for differentiation, as the evidence proves the real affection, and fatality occurs so early as to prevent the opportunity to do so.

In the cases of hemorrhage in which symptoms come on more or less slowly, diagnosis is at the first more difficult to make out. Especially is this true if the patient is a

neurotic individual, in whom the reaction after the accident and its horrors appear, adding its influence to what little pathological state there may be present. If these points are not prominent, the gradual oncoming of symptoms, their mildness, and the interference with the sensations not increasing, are all fair evidences of the condition of hemorrhage being present. In such cases the symptoms will gradually fade away and get better as the hemorrhage is absorbed, none of the severer signs will appear, and all the functions will return to their full capacity.

In the type of neurotics an individual may be found who has either walked or has helped himself to a degree sufficient to set aside the fact of absolute paralysis; while in cases in which paralysis appears to come on later, a general neurotic tendency should lead to certain suspicions of the nature of the condition. The absence of other signs beyond the will, as cystitis, retention of the contents of the bowels or bladder, and bedsores, should as well be guides to the proper diagnosis. The nearest approach to a lesion of the cord will be presented by those few cases of hemorrhage in which some degree of personal action has been present for a short time succeeding the accident. Much closer observation is necessary to differentiate these, and in numbers of cases it will be impossible, for the time being, to do so; but after the lapse of a short period the case shapes itself and the permanent elements are left prominent.

Prognosis.

In lesions of the spinal cord due to laceration or impaction from a fractured or dislocated vertebra, the prognosis is always grave. All such lesions invariably manifest

themselves by gradually increasing symptoms which undermine the general strength of the individual. The cystitis, pyelonephritis, and retained urine and fæces are factors of toxæmia; the bedsores and atrophy are evidences of decreasing nutrition; the appetite fails, and death ensues.

When the lesion is in the cervical region, death ensues shortly from the effects of embarrassed respiration and the indirect effects of the same upon the cardiac centres. In the less severe lesions, as of hemorrhage into the cord or its envelopes, recovery ought to ensue, and all symptoms abate as the clot is absorbed. If the hemorrhage is coupled with a severe neurasthenia there will be some doubts as to a permanent recovery.

The presence of complicating conditions elsewhere may so influence the case generally as not to permit a prognosis to be made at the first instance, no matter how slight the injury may be. Therefore, it is well to postpone the prognosis in such cases until the conditions clear up. One should be wary about ever giving a discouraging opinion as to the outcome of any case of spinal injury, unless it is ascertained without the shadow of a doubt that the case is one of a true spinal-cord lesion caused by dislocated or fractured vertebræ, in which case a grave prediction may safely be made.

Treatment.

In the face of the prognosis given above, there is not much to offer in the way of treatment in cases of spinal injury, beyond the hope of giving temporary relief.

At the time of the accident the individual should be treated symptomatically, all pain, and as far as possible

mental anguish, being relieved by very full doses of morphia and strychnia, one-fourth to one-half grain of the former and one-thirtieth to one-twentieth of the latter remedy, given hypodermically to secure as prompt action as possible. Removal of the patient at once to good, warm quarters, and no further than this, should be the rule, as in all severely injured persons. Travel should be absolutely prohibited until a careful examination has been made, for if the cervical vertebræ are dislocated, instant death may ensue through an increase of pressure at this point upon the cord. If shock is present, hot bottles surrounding the individual and stimulants hypodermically administered are advisable.

An examination of the back, from the head to the sacrum, should be carefully made for marks of bruising and irregularity in the lines of the vertebræ, when free crepitus may possibly be discovered. As soon as such condition is made out with enough positiveness to locate the injury, and its coexisting symptom, paralysis, points to lesion of the cord, the operation of laminectomy should be done, as spoken of under the head of fracture of the spine, all fragments and blood clots which may be the cause of damage being removed. Suffice it to say that while it is advisable to do this operation even for the very small percentage of cases that are relieved by it, it should be performed at the very first opportunity if any success whatever is to attend its performance. Experience proves that the injury to the cord is done at the moment of impact, and from that moment the cord is permanently damaged beyond repair by either operation or subsequent processes of nature. The cases of improvement after this operation are, in one sense,

those in which hemorrhage only has occurred, or those in which no impact has been given the structure of the cord, and which would have improved just the same without operation.

Yet, under favorable circumstances, such as proper quarters, assistance, knowledge of the operation, and when the probable results of the latter are understood by the patient and his family, the operation is advisable as a satisfactory measure. Oftentimes the operation proves that fragments of bone are not at all pressing upon the cord, although the latter is dead as to function.

Whether an operation is done or not, in all cases absolute rest should be enjoined for a time, lest fragments be displaced or any hemorrhage increased. It is very proper to apply a plaster-of-Paris jacket or a stiff corset of some material. Attention should at once be directed to the functions of the bladder and bowels. Catheterization and irrigation of the former with boric-acid solution, and free enemata with a high rectal or colon tube to the latter, should be daily practised; oftener if required. In the types of mild cases suggesting hemorrhage only, hygiene should be strictly observed very early, and every effort made to stimulate the functions of the body.

Water-beds should be employed when possible in the severe cases, to secure relief from pressure and consequent bedsores. Tonics, stimulating foods, and other measures should be employed to secure comfort of the patients, in which state they should be allowed to pass their remaining days, plenty of anodynes being used, if called for, to ensure absolute freedom from pain or distress.

Electricity is of use only as a placebo in such cases,

although when hemorrhage has occurred, or permanent relief is expected by reason of a return of the cord to its normal condition, it may be of value as a means of both stimulating the muscles and keeping them from getting flabby, and assisting in improving the individual with the idea that he is to recover, and thus prevent neurasthenia. When it is to be employed the faradic current is to be recommended.

CHAPTER XIX.

TRAUMATIC NEURASTHENIA.

Traumatic neurasthenia may be defined as a state resulting in a person from being in a severe accident or shake-up, in which the more or less severe tossing about, coupled with the fright and terror of impending bodily injury or death, has brought on a condition of neurosis in which the individual actually believes, or can by suggestion be made to believe, that he is the victim of, and suffers from the pangs of a severe injury, while there is no material evidence that such is the case.

This definition carries with it the inference that all such cases are either psychic neuroses, hysteria, or pure simulation. While it is possible that the individual may be irresponsible for the appearance of severe symptoms at the time of the accident, it is undeniable that the great majority of these cases have proved themselves to be non-pathological, but the patients' complaints continue as long as there is any probability of their being able to sue the railway company in whose cars they received the injury. That this idea acts as a specific cause is evidenced by the full recovery of a large percentage of cases immediately after a settlement of their claims.

In regard to this condition there is much to be thoroughly considered. There is no doubt that there are cases of genuine neuroses caused by, or starting from, an experi-

ence in a railway accident. Cases are cited by reliable authorities showing that a state of neurasthenia may develop and continue as a result of other accidents than those occurring upon the railway, and in which there was no possible chance for the question of damages for bodily injuries to arise in the case.

There is no question that many circumstances influence this matter in the minds of individuals. Some would give no thought to anything but their own bodily condition, and finding themselves uninjured, would even go to the assistance of those who may have been injured in the same accident. Another, to whom the loss of time or some circumstance connected with his daily plans would be of importance, gives all thought to that, and loses sight of any idea of personal injury, paying no attention to slight blows or scratches in his anxiety to go on his way.

Cases of the types described above represent, by far, the minority among those caught in a railway accident.

The average person, upon receiving any blow or shock, especially in a collision or derailment with its consequent excitement and moments of doubt as to personal harm, will be attacked with a nervous shock or fright of a degree that usually passes at once into a more or less permanent condition, and this whether or not he is materially hurt. It is a noteworthy fact, and we may well expect to find, that females and those individuals who are possessed of a high nervous temperament, or who are hysterical, will be found among the first to complain, and appear to be badly injured. Added to this is the idea ever present in the minds of individuals that no matter what the injury may be, the railway company will have to pay for it, and in direct pro-

portion to its severity. This creates a suggestion to make out the case as bad as possible, even if a degree of simulation is necessary.

Signs and Symptoms.

Neurasthenia is not a condition to be noted by signs and symptoms during the early period succeeding an accident. It is rather a state beginning at such a time, and gradually exhibiting its prominent symptoms

If, therefore, spinal-cord injury is excluded, and no other material injury is present, the complaints of a person that he is injured may be looked upon as entirely simulated, or the result of hysterical excitement.

There is no way to determine whether or not a person is shamming during the first moments following an accident, provided he complains of injury or helplessness. At this time it is the duty of every one to assist in getting all persons into comfortable and proper quarters, as suggested in previous chapters.

If a person is found helping himself and using all his extremities, the fact that the spinal cord has escaped injury is at once established. It would not be our province to suspect any neurasthenia or malingering in case there was a material injury, such as a fractured bone or laceration of soft parts, for the latter would command the more careful attentions, and there would be sufficient reason for nervous symptoms. In the absence of such material injury, however, and if the individual gives evidence of ability to help himself more or less completely, complaining of many pains, bruises, or injuries, none of which seems to be of sufficient gravity to account for the suffering he complains of, this is

a case which should be carefully noted, and the surgeon be on his guard as to what he admits regarding such injuries, until a more positive diagnosis can be made.

There are individuals in whom no bad symptoms are present at the first instance, and who care for themselves entirely, going about their business for days after the accident without consulting a surgeon or thinking themselves at all injured. Finally the suggestions of anxious friends induce them gradually to believe that they have suffered sufficient injury to lead to bad results. The idea of compensation may not have dawned upon them until this time, and adds its influence as a cause for the appearance of vague symptoms referable to their alleged injuries, and they become invalids at once.

It is to this class that our attention should be carefully directed, and it is conceded to be one of the most difficult tasks to determine the true nature of such a case, and place it in its proper position.

Diagnosis.

In the diagnosis of this condition the history of the injury and the immediate subsequent symptoms, noted before the individual has had time to realize his situation, will be of great aid.

The cause of, or the manner of receiving, the injury may be found to be totally incapable of producing such a condition as is complained of by the individual, and the person may have been seen to appear entirely unharmed for a longer or shorter period subsequent to the accident. In case the person takes the question of compensation immediately under consideration, this fact will soon be noted,

and give rise to the suspicion that a feigned condition is at hand. Many times the patient is being "coached" by lawyers or physicians, who are personally interested, so that it is a delicate matter to decide properly as to the merits of the case.

While it is just to believe that malingering is not attempted by the more refined people, yet when any motive for such is suspected, there should be no hesitation in using careful scrutiny.

In malingering, or hysteria, the symptoms presented by the individual are very erratic, and frequently feigned in such a poor manner that their falsity is easily detected. Exaggeration, rather than otherwise, is very apt to be exhibited, while a general disregard for the proper relations that should exist between cause and effect is noted. Differentiation between true lesion of the spinal cord and hysterical, simulated, or other conditions with like subjective symptoms has been fully noted in the previous chapter.

In the absence of material evidence the symptoms as described by the patient are at first general, and finally circumscribed to a location where some external abrasion or soreness exists. Most frequently the complaints are referred to the spine, and probably for the reason that the muscles of the back are prone to be sprained in any "shake-up," and as well for the fact that "railway spine" and "paralysis" are uppermost in the mind of the average individual. Tender spots may be complained of, indefinitely located along the lower region of the back.

The individual who has a genuine neurasthenic condition, and is innocent of any intent to deceive, and free from any motive to enlarge upon his symptoms, might not

refer to any particular part of his body as being affected, but may present such general symptoms as would be noted in any condition in which the normal vitality has been disturbed. In these we should expect to find complaints of neuralgic pains, especially in the head, thorax, and back. There might be feelings of numbness in the arms or legs, or a prickling sensation in superficial parts of the body. While such individuals may walk about, it may be with some difficulty and fatigue, on account of muscular weakness usually present, discoverable by means of the ordinary tests. The reflexes are apt to be exaggerated, in keeping with the high tension of the nervous system. These individuals do not appear so excited as the malingerer ordinarily does, but may be irritable or uneasy, and may even present symptoms of melancholia.

It might take some days or weeks before a train of symptoms like the above is manifested, and in fact there is no regularity to be expected in the form or duration of any of the phenomena.

When paralytic symptoms are complained of, it is expedient at once definitely to decide the condition. If these are simulated or psychic, they can be detected by the usual tests. If such symptoms cannot thus be clearly defined, an anæsthetic may be employed, by means of which the most intractable cases give evidence of the power resident in the extremities.

There are, however, cases on record in which the most expert have been hoodwinked by the malingerer. Great will power, aided by suggestion and schooling, seems to give these persons absolute control over even their reflexes, and power to baffle all ordinary attempts to disclose

the real condition. Advantage must be taken of an unguarded moment in which to disarm the individual, and thus either surprise or scare him out of his so-called paralysis.

To illustrate to what perfection a malingerer can attain, the following report of a case is noted, taken from the *Railway Surgeon* of March 26th, 1895:

"One, Fannie Freeman, suffered injury (?) several times by falling from street and steam cars, each time so cleverly simulating paralysis of the lower extremities as to escape detection, although examined by several able surgeons, upon whose decisions she had received sums of money from various railway companies in settlement for damages. Before beginning her fraudulent work she had put herself through a course of training, by which she was enabled to endure the most severe, sudden, and unexpected pains and shocks, without the quiver of a muscle or the wink of an eyelid. Pins could be thrust into her legs without any flinching on her part, and she could not be surprised into any painful expression whatever. Other symptoms of great distress, and total inability to support herself on her legs, were so cleverly feigned as to escape detection as being spurious. She was finally exposed in Chicago by the 'Rock Island' officials, where effective detective work succeeded in observing her movements through a 'peep-hole' opening into her bedroom. It was found that she immersed her legs in water just previous to being examined; which procedure, no doubt, assisted her to control herself. After the experts left, she was seen to get out of bed, and 'after doing a few fancy dance steps, kicked her foot over the back of a chair.'"

In the same journal, of same date, is the copy of an interesting letter, in which the "motive" is easily discovered. A man writes to his medical attendant for "points" in order to make his injuries "valuable." He says: * * * "I am about under examination of to Speclist of nervious desieses who are in favor of the co. I want to make the case as strong as possible. my ingers are bad anough dont wish them any wors; but I want to make them blieve that I am a good deal wors than what I am. Then this is a case the worse the inger and danger of case the larger the Sum, as I havnt got a Dr. book and dont want to trust eny Doctor here. I ask you to assist me in this case. post me what to do to make the case very dangerous, without them detecting it. nothing goes in this case but nervious deceses." * * * Physicians testified to finding no evidence of organic paralysis in this case, and the consensus of medical opinion was that the man's condition was undoubtedly the result of deliberate feigning. This was so cleverly done, however, that he succeeded in getting the confidence of the jury, who awarded him $9,000 damages.

Hysteria plays so important a part in this particular class of cases that it must be considered. In this regard the previous history of the individual, coupled with his family history, should be sought, which if truly obtained may be of great assistance. We cannot admit that this latter condition originates *de novo* at the time of the accident, although we believe that it may be brought out of a latent state by a railway accident, even though the person never previously exhibited symptoms of it. If, therefore, the hysterical element is believed to enter largely into the case, many of the incompatible symptoms found present

may be laid at the door of this state, and the case becomes one of either simple hysteria or hysterical neurasthenia. Paralytic symptoms, not detected as feigned, nor found to be the result of lesion of the spinal cord, may be ascribed to hysteria.

This decision may not justifiably be reached in several days, or perhaps weeks, succeeding the accident. The non-appearance of the usual conditions noted subsequent to true lesions of the cord, and the marked improvement in motor and sensory power usually found in these spurious cases betray their true identity.

The malingerer can usually be caught if due regard be given him in conducting the examination of his case. Caution should be exercised not to give any suggestion by word, act, or expression that any lesion is, or is not, being discovered. Permit him to do most of the talking, and give him every opportunity to enlarge upon his symptoms. Many will look for a suggestion upon which to act, and be anxious to help the examiner discover some injury. By careful observation during several visits the irregularity and variability of the symptoms will readily be noted, and the malingerer exposed.

Course and Prognosis.

The course of traumatic neurasthenia springing from railway accidents depends to a great extent upon the true motive of the individual, as to whether or not he is in expectance of a compensation for his injury. In the latter class of cases, *i.e.*, those who do not expect compensation, which are indeed very rare, but in which a real neuras-

thenic state may be present, the general condition of the body continues to become impaired until the debility is very pronounced. Loss of flesh, of appetite, and of general power succeed, while the consequent conditions of deranged digestion and irregularity in all the functions present themselves in due course of time. The absence of paralysis is noted by the retained power in the sphincters and the presence of motion and sensation. Mental irritability and lack of interest in worldly and business affairs may come on in spite of the fact that no lesion can be found to account for it all. This is the result purely of the shock to the nervous system which baffles all manner of treatment, and from which the individual cannot be rescued.

It is decidedly more frequently found, however, inasmuch as the individual expects to be compensated for his injuries, that just so soon as a settlement is made, a recovery from all the symptoms present in the case rapidly ensues. In fact, it is believed that upward of nine-tenths of all cases of those injured upon the railway may be classed under this head. In those cases which are fraudulent from the beginning, and are but shamming, the same rapid improvement, or even sudden suppression of all of the symptoms, takes place when they find that they are unable to get their case in proper shape for presentation.

A few cases are recorded, both among those expecting and those not expecting compensation, in which improvement will be gradually and permanently noted, no matter what disposition is made of their case, although years may pass by before they are fully restored to health. Hysterical cases usually follow a similar course to this. Where muscular sprain or other physical lesion has been a factor

in the case, the improvement in the neurotic symptoms may be found to follow rapidly upon the relief of such lesion, and the return of the injured parts to their normal uses.

Much will always depend upon the attendance and companionship surrounding the individual. Proper tact will overcome what nothing else will, and lead to much more favorable results. On the other hand, suggestions and impressions given the person, of a discouraging nature or in the line of damage suits, etc., will but add to the continuance of the nervous state.

Death from traumatic neurasthenia *per se* may be said never to occur.

Treatment.

In regard to the treatment of these cases there is but little to advise.

In case the subject is found to be expecting compensation for his injuries from the corporation thought to be at fault, every effort should be made to have a settlement made, for with the solution of this difficulty a potent cause for disturbance in the patient's condition is at once done away with.

All symptoms that the patient complains of should be looked after, but care taken in reference to false statements made by him. Follow up his complaints by minute examinations of all their phenomena. Believe only what is actually seen, and ask for evidences of extraordinary symptoms, as vomiting or discharges. Give medicines for such symptoms as appear, or that are complained of, even if but to allow free play. Do not aid in any way his search for

new symptoms. If any organic lesion is complained of, its presence or absence will be detected. Be non-committal in regard to the probable outcome of the case, beyond giving expressions of an encouraging nature. Avoid such auxiliaries as crutches, rolling-chairs, and the like, as they may lead the patient to depend upon them for support instead of upon his own powers.

In cases of hysteria, or true neurasthenia, in which there is a truly serious condition, and in which the idea of compensation is entirely out of the question, methods of treatment similar to the above should be adopted.

Special attention should be given such symptoms as appear prominent. Electricity, coupled with restoratives, will be found of great benefit. Narcotics should be carefully avoided, for fear of engrafting habits not easily broken.

Further than this, there is not much to offer. The patient should be kept in as wholesome and encouraging a frame of mind as possible, and benefit may be derived from a change of scene, sea voyages, or other means of diverting his mind from his personal condition. He should be assured of his certain eventual recovery, and assistance given by suggestion in the line of improvement that may be noted to appear.

Hypnotism may prove to be the mystic power that will eventually be employed to overcome this state, when the relation between cause and effect seems to be but mythical.

CHAPTER XX.

JURISPRUDENCE IN RAILWAY SURGERY.

THE great frequency with which railway accidents are followed by damage suits on the part of those receiving, or claiming to have received, injuries, and the fact that the surgeon who attends to the injuries will be called upon to testify regarding these, give to the jurisprudence of railway surgery an importance second only to the treatment of the injuries.

Much has been said in previous chapters of the rapacity of the average individual in demanding compensation for injuries that are perhaps but slight or entirely simulated, and advice frequently given urging the surgeon to be careful regarding his statements as to the nature of the injury or its prognosis, for the reason that at a later time the case may have assumed an entirely different aspect, and it may be awkward to be confronted in a court of law with a diagnosis or prognosis hastily made at the beginning of the case.

When an injury is present beyond dispute, there is no reason for withholding any fair expression regarding its nature or its probable outcome. At the time of the accident it is not consistent to make any extended examination of injuries beyond what presents, but that examination should be reserved for a subsequent visit, and after the first excitement of the patient has quieted down.

The surgeon should, from the very beginning, maintain strict neutrality as to the relation the railway corporation may bear in the case, and attend solely to the patient's personal condition.

It is of paramount importance in every railway injury to make a thorough observation of the exact conditions surrounding the individual when first seen, of the nature of his wounds, if visible, and to obtain an account as to how the accident occurred, from the bystanders, and also from the patient if possible. These facts should be recorded on paper just as soon as convenient. It is also just as important to keep accurate notes of the progress of the case from the day of injury to its termination.

At the first opportunity an examination should be made of the patient's body for evidences of previous injury, denoted by scars or deformities, and their history elicited. The fact whether they are congenital or have been acquired should be determined, and if the latter, the date and cause of the injury that produced the scar or deformity, noting the location and appearance of each. Inquiry should be made as to the health of the individual previous to the present injury, especially regarding the presence of the tuberculous or syphilitic taint, and as complete a family history as possible should be obtained.

If all these suggestions are complied with, the surgeon will possess a complete record of the case, which at its termination will be of great assistance in deciding just what the accident is responsible for in the person's condition. It will also be of aid and satisfaction for reference when the surgeon is called upon to give evidence.

Now as to the conduct of the surgeon during the progress of any case.

If the individual inclines to the idea of presenting a claim for damages, he will very likely look to his physician for advice, or at least talk with him in relation to the matter. If the attending physician is also the surgeon for the company thought to be at fault, he is in a very delicate position. His duty, however, is unquestionably first to his patient, and second to his company, yet he must not overlook his plain duty to see that justice is done to both, as far as he is able.

When the railway company is responsible for the injury, on account of carelessness or negligence on the part of any one of its agents, and is willing to admit it, the surgeon should inform it of the exact condition of the person's injuries, as to their quality, extent, and probable consequences. He should not attempt to act as a claim agent for the company in adjusting the amount of damages, but he may, upon request, give advice as to the length of time the injury will disable the individual, and the probable expense of care, medicines, and surgeon's fees. At the same time, he can with propriety give advice as to what he believes to be the proper course for the individual to take, *i.e.*, as to whether it would be better, or not, for the patient to settle the case upon the terms offered by the company. As he is in attendance, the patient should be entitled to any advice along this line which, by reason of experience, the surgeon is capable of giving.

Therefore, if he finds the case deserving of compensation, and the railway company is willing to make a settlement, there is no reason why the surgeon cannot assist

both his patient and the claim agent in adjusting a satisfactory amount. If the company's offer is just, he should so inform his patient; if it is not in justice to the probable outcome of his patient's injuries, he should so inform the company. With due regard to both his clients, an interest can be manifested without being partial to either of his obligations.

On the other hand, when the surgeon is confident that he has a case of simulated injury, and the patient is determined to demand compensation for such alleged injury, he should advise his company as to the true state of affairs, and refrain from giving the individual any assistance whatever. His duty in this case is to the railway company.

In these spurious cases it is doubtless proper for the surgeon to inform his patient of his conclusions, frankly telling him that there exists no injury or condition upon which he can justly base a claim. Before doing this, however, it is advisable to have counsel associated in the case, and have him thoroughly examine the patient, in order to corroborate the diagnosis of the attending surgeon. This fortifies the latter in his position, for which he may at a later day be taken severely to task.

In railway injuries, the real nature of which is obscure, a hasty decision should not be made. A sufficient time must be permitted to elapse in order that the case may shape itself, and perhaps disclose its identity.

There are cases of hysteria and neurasthenia, resulting from some circumstance connected with a railway accident, in which no evidence of material injury is present, nor could the injury possibly have occurred. In such instances it should be the aim of the surgeon to dissuade the patient

from entertaining any idea of holding the company responsible, and he should prohibit any one from talking to his patient regarding the accident. He should also be positive in his statements to the friends or advisers of the individual that no suit for damages could possibly be sustained.

When a surgeon is acting solely in the interests of a railway corporation, and is permitted to examine the individual alleged to have been injured, his object should be that of determining the precise nature and extent of the injury, if any, received, regardless of whatever reports may have been made to him.

In lesions that are material and easily determined, there is no reason for doubt as to the condition. It is to the obscure points and features that require for their development very serious lesions that the earnest attention of the examiner must be directed. Guided by his knowledge of anatomy, physiology, and the functions of the body, coupled with his experience in nervous disorders and paralytic conditions, he should be painstaking in carrying out every test and means at his disposal for the completion of a positive diagnosis.

Much circumspection is requisite in the manner of approaching individuals who are to be examined. The attitude that some persons assume may materially aid or impede a fair examination. Hysterical subjects may entirely thwart the surgeon's effort to make any examination whatever, or the sympathetic (?) interference of friends and attendants may completely bar the way to a satisfactory inquiry. Such cases will necessarily result in leaving the surgeon in much doubt as to the diagnosis, and be of

very little aid to his own conclusions, or the company's interests.

A successful examiner will not attempt to frighten or intimidate the person he is examining, but rather conduct his inquiries and manipulations with the utmost gentleness and consideration, as if the patient was indeed a great sufferer, whether he is or not.

More can be determined by observation of the patient's actions than by submitting him to a long, tiresome questioning designed to confuse.

Upon concluding an examination a full report should be made to the company, with an opinion in regard to the cause, extent, and probable resulting condition of the injuries received by the individual. Appended to his report should be the statement of the consultants in the case, corroborating the surgeon's conclusions or otherwise detailing their opinions.

When it becomes the duty of the railway surgeon to appear in court, and testify as to his knowledge of a case of injury, the time arrives when the records, which have been preserved, will prove invaluable. Positive statements can then be made regarding the condition of the individual during the entire course of attendance.

In cases having true merit, in which the railway corporation is responsible, and is willing to compensate the individual, the surgeon who has attended the person will figure but little in the matter, for when settlement is made outside the courts, it is made upon grounds which cover other important points than the mere injury. When a claimant will not accept the company's offer, but carries his case into court, there is but little for the surgeon to

testify to, save the history of the case, its appearance, course, and result. Too frequently, the exact nature of the injury and its results are set aside for the more momentous questions of liability and the adjustment of damages.

In giving testimony, the surgeon is advised to state the facts, and refrain from being partial to the company's interest beyond reasonable or consistent limits. If he is questioned hypothetically, he should be guided in his answers by his personal experiences, and his convictions based upon such knowledge. He should never be afraid to answer "I do not know" if he does not, for by so doing he displays shrewdness more often than lack of knowledge. To such questions as are intended to bear directly upon the case, or class of cases before the court, he should be brief and practical in his answers, avoiding all technical terms or lengthy descriptions. He should remember that an opinion must not be vague, but eminently probable and reasonably certain. If an answer be made in the form of a definition, it should be so clear that everybody can understand it. If an ambiguous question be asked, insist that it be made clear before answering it.

In fact the surgeon should remember that consideration of his own interests is of the greatest importance, and while upon the witness stand he should admit nothing but the truth of facts possessed, or of convictions firmly established in his own mind.

It occasionally happens that a railway surgeon is called in by a company to give expert testimony in a case that he has never seen, and knows nothing of save what has been communicated to him.

Before attempting to appear in any such interest he should make a study of all the facts in the case, and become thoroughly satisfied that the testimony which it is desired to bring out is not incompatible with such a case. A thorough understanding of what is expected of him should be obtained, and if this does not coincide with his own views or convictions, he should refrain from going on the stand in such interests.

In any questionable case it is wise for him to cross-examine himself upon every point, in order to be better prepared to combat the irrelevant and absurd questions that are frequently asked of him.

As in all medico-legal cases, the surgeon should fortify his views on any subject by free reference to standard authorities. To stand alone in one's opinions, or be diametrically opposed to the teachings in recognized text-books, is so insecure a position as to render such opinions practically valueless, unless supported on exceedingly good grounds.

It should be remembered that, at the present day, expert testimony is looked upon as so very elastic and confusing that it bears but little weight with the average jury. Men of equal prominence may be heard giving evidence for and against any case. A learned professor may be confronted on the witness stand by his recent student, and the jury be unwilling to appreciate the difference in value of the testimony of the two men, so long as they are both doctors.

In the face of these circumstances it is conceded that the railway surgeon might better be called upon simply to relate the plain facts in any case, and substantiate his tes-

timony by the personal condition of the injured man, as may be evinced by his appearance and the testimony of laymen and surgeons in corroboration.

If the surgeon has been thorough in the management of the case in question, and by so doing has obtained a knowledge of the true condition of affairs, it will be impossible to weaken his position; and furthermore, if the litigant is made to submit to a personal examination, it will but corroborate all that has been claimed and testified to. The results of such a procedure will reflect great credit upon the surgeon in attendance, and be of the utmost satisfaction to the railway corporation which has employed him.

CHAPTER XXI.

THE EXAMINATION OF EMPLOYEES.

THE fitness of a man to do a certain kind of work does not altogether depend upon the skill he is possessed of for that particular employment, but he must present physical capabilities compatible with every detail in the field of such work, in order that the same can be done with safety to himself and to those whose life depends upon the results of such details.

A railway man should be free from many defects permissible in mechanics and laborers, and as perfect in physique as a man can be.

The ability to move about among cars that are being continually switched about, to get on and off them while in motion, to serve in the management and conducting of passenger service, as well as to locate and distinguish the various signs and signals used in the service, and to do all this with celerity, dexterity, and safety to all, are the indispensable requisites of a successful railway employee.

To this end many companies are now selecting their men, in order to get those who are as free from defects as possible.

The following form of blank, if properly filled out, will give the opportunity for the best selection. Many of the points are intended only as a matter of record, but do not necessarily preclude the probability of the applicant's fit-

ness, providing proper attention be given the condition in the manner noted below. A systematic examination is necessary, and the importance of the several questions will be commented upon below the blank form appended as a matter of guide.

Form of Examination Blank.

.....Railway Co.

Physical Examination of Mr..... made this ..... day of ....., 18.....

1. Name, ... 2. Age, ...
3. Occupation desired, ...
4. Weight, ... 5. Height, ... 6. Stature, ...
7. Congenital deformities of body or limb, ...
8. Acquired deformities: *a*, Fractures, ...
   b, Dislocations, ...
   c, Old injuries and scars, ...
9. Muscular tone and power, ...
10. Chest: *a*, Heart, ...
    b, Lungs, ...
11. Abdomen: *a*, Liver, ...
    b, Kidneys, ...
    c, Hernia, ...
    d, Hydrocele, ...
    e, Varicocele, ...
    f, Prostate, ...
    g, Hemorrhoids, ...
12. Special Senses: *a*, Vision, ...
    b, Color-sense, ...
    c, Hearing, ...
    d, Speech, ...
13. Habits: *a*, Stimulants, ...
    b, Tobacco, ...
    c. Narcotics, ...

.....M.D.

The name, age, and occupation desired (1, 2, and 3) are for matters of reference; weight (4) and height (5) should be along comparable lines, while by stature (6) is noted the general form and condition of the body as to health. Under congenital deformities (7) of the body should be noted shortened extremities, which in the leg, as well as talipes, would be undesirable as causing lameness; cross-eye, which would tend to cause misinterpretation of signals; tumors of sufficient size or location as to interfere with free action of the body at all times; web-fingers, or hare-lip, both interfering with the powers of their respective parts.

Under acquired deformities (8). we should look for evidences of old fractures or dislocations, or other injuries or scars, and make a record of them, to be compared with possible after-reports if the individual should ever be injured, noting as well whether the results from these have left any inability properly and fully to perform work of any kind.

As to the muscular tone (9), this can be determined by tests applied to the back, arms, hands, and legs by means of weights or various feats devised by any one.

In the chest examination (10) any mitral disorder of the heart or marked tuberculosis of the lungs should be cause for rejection of an applicant for service, on account of the possibility of an untoward result from the disorder, coming on possibly at a moment when action by the employee would be most important.

In the abdomen (11) we should find an absence of history of gall-stone or renal colic, of albuminuria, of difficulty in urination, or of hemorrhoids, lest a recurrent attack

prevent the performances of an important duty for a moment. If hernia exists it should be well supported by a suitable truss, and if hydrocele is present, it should be kept emptied so not to interfere with free motion. A varicocele calls for attention by support or operation.

As to the special senses (12) it is demanded: Firstly, that vision be good, either naturally or by means of proper glasses; and secondly, that the distinction of colors be practically perfect, as determined by the proper tests noted in the next chapter.

Hearing is also important, and normal condition in both ears should be proven. Speech should be sharp and prompt, any stuttering or stammering being considered as a defect sufficient to disqualify the individual.

In habits the applicant should be a total abstainer from alcoholics, beer, and narcotics, and moderate in the use of tobacco.

Altogether, the examination, to be satisfactory, should prove that the individual can run, jump, and move actively about, that he is strong, free from organic disease, perfect in all his special senses, and good in habits. Any condition other than these should be a just cause for rejection.

* It is very probable that some of the defects or conditions noted in the examination might not unfit the applicant for certain kinds of work in the service, and this fact can be determined and an adjustment made without any detriment to the company or injustice to the applicant.

When any employee reaches the age of decline, no matter how rugged he may have been, the fact should not be lost sight of that he is a subject for pensioning, and

should be retired from positions of danger to himself and others. With propriety and considerateness he may be employed in various ways where damage cannot result from any acts of omission or commission he may be guilty of.

CHAPTER XXII.

EXAMINATION OF THE SIGHT AND HEARING.

THE matter of testing sight and hearing is one of the most important of the physical examinations to be made of a prospective railway employee. So much depends upon the proper interpretation of signals by the trainmen that any abnormality in the senses of sight or hearing may lead to the occurrence of very serious accidents.

SIGHT.

In regard to the eyes, it is very essential to determine defects in acuteness, range, or field of vision, or any failure to properly distinguish colors.

To be acute in vision, one should be able to distinguish the form and nature of objects at a considerable distance; in range he should be able to see objects and printed matter within a reasonable distance; and as to field, he should observe objects, either moving or stationary, within a wide angle to the body.

In many individuals there is a congenital defect in one or other of these particulars, rendering them incapable of recognizing the fact that they do not possess perfect vision. In others, such conditions arise and advance slowly, and are seldom appreciated by the person until examination proves it. As a fact, therefore, the proportion of per-

sons with optical defects reaches quite a high percentage, and upon examination it is found that in railway employees it reaches nearly twenty per cent.

Many of these defects are slight, and would not interfere materially with the proper interpretation of the signals, forms, and various structures about the railway, but in some persons they are so pronounced as entirely to incapacitate them to perform railway service.

Color Sense.

As to the color sense, the defect is found to consist in the inability of certain individuals to properly differentiate between certain colors. The number of persons so afflicted reaches about four per cent, and is so important a defect as to make this comparatively serious. There is no doubt that the matching of tints of colors is a difficult procedure, and seldom accomplished by any one. The shades of light that may fall on any color may so change it as to make it appear to be another. When the colors of red, green, yellow, or white, or dirty shades of these, cannot be promptly recognized, or are confused to the individual, such a person may be said to be color-blind. One point should be observed, however, and that is that those persons who are employed upon the railway, and are in daily contact with the various colored signals used in the service, are acutely sensible to the purposes of such colors, and will respond promptly to the order the signal calls for, and yet may hesitate regarding the name of the color submitted or the matching of the same.

Nearly all optical defects are remediable by proper

lenses, and when so corrected such persons may render as perfect service as if no defect existed. The few cases found with defects from disease or injury are not so easily adjusted, but time and repeated examinations will prove whether, with or without lenses, they possess proper vision. As to color defects, they are usually congenital and permanent. No education or appliance will correct the difficulty, and persons who are so affected are beyond help, and cannot be safely entrusted with any position in active railway service.

Methods of Examination.

In examining for defective vision, the use of the Snellen test types, exhibited in a good light, is advocated (see Fig. 82). Testing one eye at a time, the various sized types should be promptly and perfectly distinguished at the varying distances, by each eye. The cards with radiating lines, or "clock-faced," should be used to determine if astigmatism is present, the clearness or blackness of lines of certain angles over others marking the degree and angularity of defect.

So far, the examination may be conducted in a closed room, but for range, field, and acuteness of vision, the individual should face a perspective where various objects, both moving and stationary, may be observed. The objects in the field should be promptly and correctly mentioned by the observer.

In case of inability to reach the normal standard in any of the tests, the test-glasses should be employed to determine the proper correction to apply. Testing each eye separately with the form of lens believed to be able to cor-

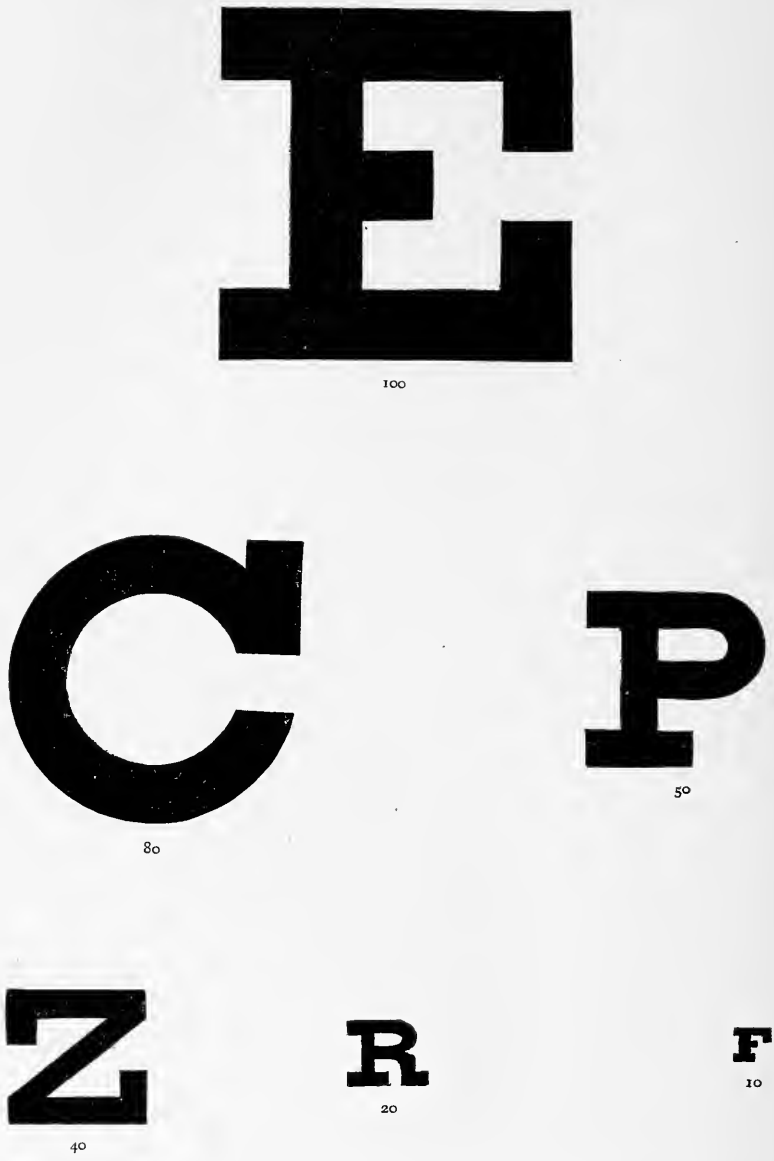

FIG. 82.—Snellen's Test Types. (To be employed at the varying distances noted under each.)

rect the defect, its degree and form may be determined. Various instruments to determine the vision and its correction are employed by many at the present time.

In the matter of correction of the vision, a considerable degree of expertness is requisite, and it should be done only by those familiar with its many details.

If any form of chronic inflammatory condition of the lids be encountered which is not dependent upon defective vision as a cause, this should be considered as detrimental to perfect vision on account of the irritation caused thereby. Such cases should be subjected to local or constitutional treatment, and be frequently examined, before their capabilities are decided upon.

Color-Blindness Tests.

In examining for color blindness the system of Holmgren, using a "stick" of colored yarns, is the one usually employed. In this scheme about one hundred and fifty tints are used. At first three test colors, light green, rose or purple, and red, are placed before the person, and he is required to match their colors with the skeins of yard on the stick. On the stick the tints are arranged in alternate shades of match colors and confusion tints, intended to test the person's color sense to the finest degree. In fact, it is a test which tends to confuse rather than to detect. While this form of test is recognized by many corporations as the standard one, and is undoubtedly scientific, yet it has some objections in not being so complete or so practical as it might be. To employ it alone, and judge an individual by the results obtained by its use, will render necessary the

discarding of many men who are to all purposes fit to do active duty so far as the color sense is concerned. To match colors perfectly is quite another thing from promptly recognizing colors and signals in colors. Whether or not the

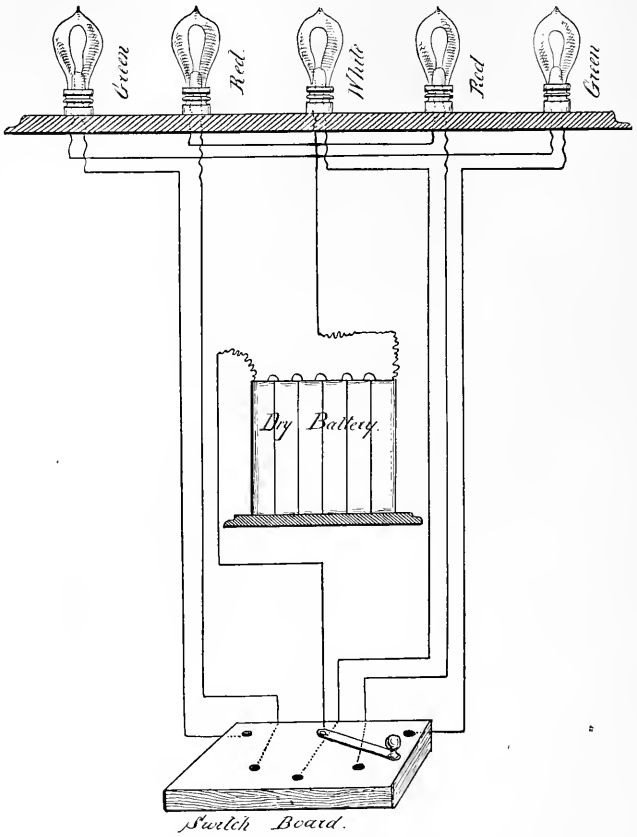

FIG. 83.—Scheme for Arrangement of Electric Lights in Examining for Color Blindness and in Flashing Railway Signals.

"yarn test" is employed, it should be assisted or supplanted by the exhibition of flags of the materials and colors used on the railway, in all shades and in all states of wear and

soil, from new to ragged. The man should name promptly the color of each flag and its significance, no matter how bedraggled or dirty the shade may be. He should name these at close and distant range.

Each man should then be taken into a dark room where a series of lights is arranged, of the kind employed on the railway—red, green, and white—each in two or three different shades. These lights, either electric or otherwise, should be so arranged as to enable the examiner to flash them singly, alternately, or together, and in varying degrees of intensity (see Fig. 83). The individual should be able to distinguish at once the light flashed, and give its significance.

This examination may be supplemented by the various movements executed in train signals, carried out by a swinging light, in order thoroughly to test the acuteness of vision in conjunction with the color sense.

Any positive defect in the proper interpretation of these tests would be a complete bar to the person desiring to enter the active railway service.

Hearing.

While the sense of hearing is not so important as that of sight, nor necessary to be so acute, an individual should be able distinctly to note the character of sounds of any considerable degree.

He should be able to hear the voice at a moderate distance, and to distinguish bell ringing and the sound of the whistle. There is no reasonable doubt but that any person riding in an engine, with its clatter and roll con-

tinually sounding in his ears, will become somewhat obtuse to the distinctness of certain sounds without there being essentially a defect of hearing.

Examination of Hearing.

An ordinary watch should be heard to tick distinctly when held at four or five feet distant from the ear, testing each side separately.

The stopping and starting of a stop-watch is the best test to employ. In addition to this, ordinary conversation should be carried on without hesitation for a distance of several feet. The perfect response to these tests will dispose of any question of defect in hearing.

If any discharge from the ears is found, the cause of it should be ascertained. It may then be determined whether it is temporary or permanent. If the latter, defective hearing will generally be found coexistent. Rather than be discarded at once, these individuals may be re-examined at frequent intervals until a decision is reached.

Forms for Blanks.

It is usually only necessary to fill in the required answers to the questions in the blank form for examination given in the preceding chapter, with "good" or "bad," as the case may be, or with a note to the effect that a re-examination is proper, in order to decide features presenting at the first examination.

To be complete, a separate blank may be employed for vision, color sense, and hearing as follows:

Physical Examination of Sight and Hearing.

Name, ... Age, ... Occupation sought, ...

Vision: Acuteness, ... Right, ... Left, ...

Range, ... Right, ... Left, ...

Field, ... Right, ... Left, ...

Color Sense: Skeins, ... Lights, ...

Flags, ... Motions, ...

Hearing: Watch, ... Right, ... Left, ...

Conversation, ... Right, ... Left, ...

Special Notes: .....

....., M.D.

Date, ...

CHAPTER XXIII.

CAR SANITATION AND DISINFECTION.

THE subject of the sanitary care of coaches and their disinfection is a feature of the practice of the railway surgeon, and it is desirable to decide as to what constitutes the best method of properly cleansing a car, with the minimum loss of time by the withdrawal of the coach from service.

It is conceded to be absolutely necessary to have the cars that are in daily service thoroughly disinfected, because of the fact that not a day passes by without each one being occupied by at least one person who is suffering with tuberculosis, or has in his clothing germs of one nature or another which have been brought by him from fields where they have abounded. The constant travelling in cars of persons thus afflicted day after day, cannot but lead to a deposition of such germs about the structure or fittings of the car, which becomes thereby a source of infection to other individuals. This is more certain to occur in the sleeping-cars, where the hangings and blankets are used day after day, and the obligation of storing them away early each morning prevents any opportunity to clean or air them.

The ordinary method of cleansing cars by simple washing, sweeping, and dusting is not so effective as the use of a germicide, the latter being absolutely necessary to combat the baneful effects of infective bacteria. Most germ-kill-

ing agents, or processes of disinfection, are destructive to the furnishings and decorations that are ordinarily used in modern coaches, and such methods are to be avoided in the selection of agents or processes intended to accomplish the object. Both solutions and gases are used for the purpose, and either may be utilized, according to the object or material to be disinfected. It is undesirable to employ agents that are poisonous, inasmuch as carelessness on the part of those entrusted with their use might result in personal harm.

The process that seems to be the most desirable, in that it combines safety and thoroughness, is the introduction of a gas that will permeate the texture of the soft materials, positively reach all the surfaces and crevices in a car, and destroy the germs that may be lodging there without damaging the fabric.

A much less expensive agent, however, is found in the employment of bichloride of mercury, in a solution of 1 : 1,000 or 2,000, which although poisonous, may, under careful supervision, be used with perfect safety.

The more common coaches, such as those used for emigrants and the smoking-cars, are plainly furnished, and usually upholstered in leather, so that washing of the floors, wiping off the seats, and flushing the closets with this solution of bichloride will subserve the purpose.

While this process may also be employed in caring for the ordinary day-coach, yet the plush coverings of the seats require that something more than a fluid should be used to permeate its texture without doing it damage. Here the method of using gas is far more thorough, and, in fact, is the only successful method. The gas to be em-

ployed is formaldehyde, which has the advantage of being harmless to the finest fabrics, neither destroying nor discoloring surfaces, and likewise non-poisonous to animals or individuals, while it will positively destroy the most virulent germs. It is impossible for a person to remain in the cars during the disinfecting process, or while the gas is being evolved; yet a free opening of the doors and ventilators will so quickly disseminate the odor that it will not be at all disagreeable, beyond some irritation to the nasal and lachrymal surfaces.

The gas should be introduced into the car after all the cushions and hangings have been loosened to give the agent a chance to penetrate all the materials. The car should be tightly closed during the process, and kept so from twenty to twenty-four hours. This gas may be obtained by means of vaporizing formalin or by sprinkling this solution freely into and over the various materials and surfaces, or it can be mixed with sawdust, which is copiously distributed. Cloths dipped in the solution and laid over the cushions will disinfect them. It is advisable, however, to employ one of the special apparatuses for the vaporization of formalin.

Of these there are various forms. In one the liquid formalin, or formaldehyde, is vaporized by placing a quantity of it into a closed container held over a flame. The gas which is evolved is conducted through a rubber tube into the chamber to be disinfected (see Fig. 84). The apparatus is kept outside the room or car, and the tube led into it through the keyhole in the door. One advantage of this method is that the apparatus is under constant supervision while the process is going on.

In the other form of apparatus paraform crystals are employed. This is crystallized formalin, and is vaporized by placing a sufficient quantity of this substance into a cup container supported over an alcohol burner. The entire apparatus must be placed in the room or car which is to be disinfected, and left to itself. By putting just sufficient alcohol in the lamp to vaporize the amount of paraform to be used, the lamp can be safely permitted to burn itself out when the alcohol is exhausted (see Fig. 85).

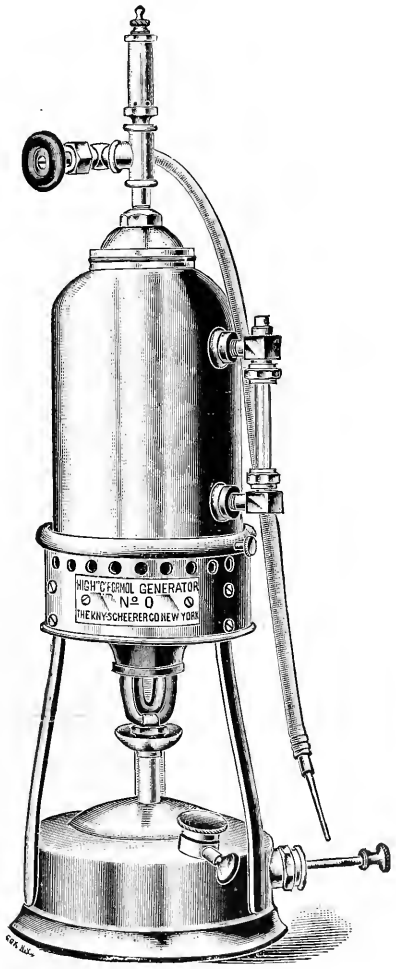

FIG. 84.—Formaldehyde Vaporizer, for generating gas from the liquid.

Of these apparatuses the "Schering disinfector" and "lamp" are the simplest, and as effective as any. In a car the larger "disinfector" should be employed, and if only a closet or section is to be disinfected the smaller "Schering lamp" is sufficient (see Fig. 86). For the destruction of the germs ordinarily met with, such as those of diphtheria,

typhoid, or tuberculosis, the vaporization of one gramme of paraform (about fifteen grains) to each thirty-five cubic feet of space is required. The ordinary day-coach contains about four thousand cubic feet, therefore it would require one hundred and sixteen grammes of paraform to effect a thorough disinfection of such a car.

While the above method could be employed in the parlor and sleeping cars if all the fixtures and bedding in them were freely exposed to the action of the gas, yet in regard

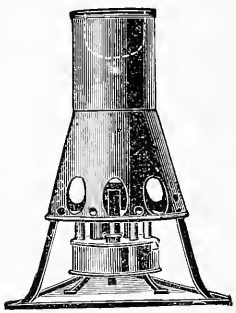

FIG. 85.—Schering's Disinfector.

FIG. 86.—Schering's Formalin Lamp.

to sleeping-cars the best method for the treatment of hangings, blankets, sheets, and pillows is to have, in one end of each car, an air-tight compartment with a metal lining, fitted with shelves or hooks for the reception of the materials, and into which steam pipes are conducted, and by thus turning live steam on the contents for an hour they may be sterilized. This is the better method, and one that is always at hand, and the compartment thus arranged could be utilized for other purposes during the interim of the necessity for its special use. The process could then even be employed while the car was in transit, thus saving much time, and occasioning no delay in the use of the car.

The water-tanks of all cars should be scalded out frequently enough to keep them sweet and clean, and the lavatories and drains flushed thoroughly with a strong solution of bichloride of mercury, sulphate of iron, or formaldehyde.

The frequency with which cars should be thus disinfected depends entirely upon their service. Cars that travel over routes taken by many invalids, as for example, those running to the Southern and Western resorts, should be disinfected after every trip. Those going over well-patronized passenger routes should likewise receive attention once weekly. In the cars of less frequented routes several times in a season would probably meet all the requirements.

The ordinary processes of cleansing coaches take fully as much time as would one of the approved methods noted above, while the latter possesses the advantage of being distinctively a germicidal process, rendering the interiors of such cars practically non-infective. By the ordinary non-germicidal methods the chances of infection are not influenced to any great degree, and while they may be apparently clean, the cars are not harmless to the individuals who occupy them in their daily transits.

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